SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1916.

No. 7, Original.

THE STATE OF WYOMING, COMPLAINANT,

vs.

THE STATE OF COLORADO, THE GREELEY-POUDRE IRRIGATION DISTRICT, AND THE LARAMIE-POUDRE RESERVOIRS AND IRRIGATION COMPANY.

IN EQUITY.

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VOLUME II.

THE STATE OF WYOMING, Complainant,
vs.
THE STATE OF COLORADO et al.

LOUIS G. CARPENTER, recalled.

Direct examination by Mr. Delph E. Carpenter:

2259 Development of country from state of aridity to state of high cultivation is better illustrated in the west and especially in Colorado, than in almost any other place in the world. The Cache la Poudre Valley is most typical of this evolution, because it has passed through all of these stages within the memory of existing inhabitants. It is valuable that this evolution should have taken place in the memory of man because the different stages are visible and have been evident within the memory of living people, while in almost all cases of older civilization at least, original conditions of things are utterly unknown; that is, development from original condition was long before present generation and very frequently before historical record, and historical record does not go back to that condition of things, so that in this case, there has been no opportunity to compare effects brought in by irrigation. We do have that information in many of our western valleys, and of them all, we have the Poudre Valley, which typifies not only what has been the stage in most of these valleys, but in most of them it shows what will be the situation in some of valleys not as yet developed as far as Poudre Valley has. In order to describe development of

2260 Poudre Valley as an irrigated area it is best to summarize its history briefly in a few sentences. There was no settlement in Poudre Valley prior to 1859. In that year there must have been some California immigrants or gold seekers that got stranded by losing cattle or something to that effect. They raised hay for gold miners at Central City, at Gregory's diggings at Black Hawk and Central City, so that settlement for next few years was largely of this character. These settlers were not people who intended to be settlers in sense of making home there, but began by merely making temporary living. Most of them stayed as they found it was a good valley and lived there until their death. This was character of first development during those first few years. Then came development about 1870, starting from impetus of Greeley Colony, bringing in then a number of people who came with expectation of making this their permanent home.

Prior to 1870 the stage of development might be considered that

of the individual, or at least that of the cooperative ditch of a few individuals as distinct from the subsequent development. It could perhaps be termed the period of individual development; that is, there were then a few individuals who came before and took a tract of land here and there, very frequently isolated, and then developed it without capital and simply by their own individual means. The

instance might be mentioned of Mr. John G. Coy in outskirts
2261 of Fort Collins, who was stranded there in 1860 or 1861 by
death of one of his oxen. This is simply case illustrating condition that often arose. A person coming in that way, without capital but taking up or squatting upon a tract of land and with limited supply of tools, instances the economic development of land by labor alone. This meant selection of tract of land that could be irrigated at relatively small cost. A tract where fall was quite considerable, where ditch could be taken out in a short distance and ditch from small stream or tributary as distinguished from large streams with relatively large fall, so that ditch would be manageable, and so that short ditch would be sufficient to get water out on ground to be irrigated. That was case with Mr. Coy and many other owners at that date.

From these individuals as instances, movement of next 10 years was simply accretion or increasing coresponding settlements. In some cases, two or three or half a dozen people came about same time and took up land close together. They might join in construction of ditch and these ditches were partnership ditches, not corporations, but built in same way, by two people having joined instead of by one person, and this really is first stage of development here, and is typical of almost all other streams.

2262 This development was confined to lands easiest irrigated by shortest ditches on main river bottoms or flats adjacent to river and below mesas. This would be the alluvial land immediately along channel of river, a strip a quarter of a mile to a mile wide, according to width of bottom. Only a small part of this land had been irrigated by overflow from time immemorial. They cover this land which had been so irrigated by overflow with their ditches. Construction of these ditches had practically no influence on overflow of stream. Their aggregate capacity was not large, nor was the acreage they supplied very large during the first 10 or 12 years. Aggregate capacity of those ditches was very much less than that of later ditches constructed when agriculture was practiced. They were small, the appropriations were often quite large principally from fact that they made large claims, especially at beginning, and water was not as economically used and they used more water, rel-

atively speaking, for various reasons, some of which I will
2263 describe later. These appropriations made by these ditches
are now known as very excessive. This is also true of their meadow ditches along river bottoms on meadow lands. Excessive appropriations were also due to lack of knowledge at time original decrees were given. They were dealing in cubic feet per second, of which none of the people at that time had very distinct idea, and

so were given decrees in language with which they were unfamiliar and some very absurd results were consequence.

In later testimony under title of "duty of water" I will take up reasons for size of these appropriations, but will pass that for the time being.

In 1870 another form of development was initiated. That was the beginning of an epoch of development on a large scale, calling for larger ditches and thus marking passage of individual ditch with some exceptions. This initiated development of upland or mesa lands, or lands outside of stream bottoms. In first stage which I mentioned, there was only small acreage under each individual ditch as a whole. Starting of Union (Greeley) County in 1870 initiated an attempt to irrigate quite a good many thousand acres in one body. This was on upland, which with many of the old settlers, was thought to be of no value. In this case, as in development of more recent years, it required larger body of land to justify construction
2264 of larger ditches and the construction of larger ditches made necessary larger aggregation or community affair of some kind, with capital and cooperation. This led to formation of colony. The colony was known as the Union Colony of Colorado and sometimes called the Greeley Colony. They planned several ditches including that canal now commonly called Greeley No. 2 and the Greeley No. 3 canal. They constructed both these canals. They also early indicated intention of building Greeley No. 1 canal which was not constructed by them, but was built at a subsequent date under leadership of Governor B. H. Eaton. He was active in its construction and was its contractor and had a great deal to do with its operation. This canal is now known as the Larimer and Weld Canal. It is also called the Eaton Ditch on account of the local connection of Governor Eaton with the enterprise. When speaking of the Larimer and Weld Canal or of the Eaton Ditch, reference is had to the same canal.

2265 These larger canals were different in degree rather than in character of work, except perhaps as regards the taking of water from the streams. When taking water in small amounts from a stream having a relatively large supply, it was only necessary to construct a headgate and some obstruction which would turn out some water. It did not have to be effective nor water tight nor need more than to divert some water which was very easily done. With later and larger ditches, taking larger proportion of stream, diversion dams had to be more effective, more expensive and more than simply a wing dam. Many of earlier ditches were so constructed as to take water at high seasons only. This was possible owing to — we do not find except in early stages, that is, the river is very large and water comes in such quantities as to subject dam to being torn out. A dam of this character has been re-
2267 tained at the head of this large Cavour canal. They have a great deal of water to waste and they don't need to hold it up tight and use it to divert all water that is available.

Dams of the Indian Canal of the character of which I have spoken, are situate at points on stream where rock has been piled in and

washed down time and again for long period of years, forming sort of a ripple or rapid in the stream. Anicuts or river dams are made with very broad base as compared with their heights, something like twenty times broad as they are high. But at the same time that that condition prevails, they don't attempt to bring up more than a fraction of the water of a large stream. When they attempt to take out a large percentage of the water, then they have to put in a new type of dam. Even in India dams of this character are for most part indicative of large water supply.

Rubbish dams prevailing in some portions of arid west are indicative of large water supply. When it becomes necessary to utilize the water in its fullest extent, they are forced to put in dams of different type. As the development increases, the two-story ditches have to be altered so that they may be able to take water at any stage of the stream. This alteration is generally made by
2268 running the ditch further up stream, or it may be made by building a dam that lifts the water. Very frequently the ditch itself is carried up stream to a new head so that it may tap the river at its bottom at low water stage or else a permanent dam is put in. This same change took place in the Indian canals, so that their flood water ditches are often times turned into perennial ditches by making them deeper or taking them out higher up stream.

Construction of larger canals involved engineering problems, differing in degree and to some extent in kind. These larger canals crossed arroyas or gulches or watercourses of considerable size. They might be troubled at times by flood waters coming down from land above and thus protection of ditch from storms was required and also carrying of ditch across arroyas and water courses by flumes or other means. Sidehill construction became necessary. A large variety of flumes were required varying with character of country. In some places the large canals might be taken out without sidehill construction. In other places such construction or even canon construction might be involved with long expensive flumes in order to bring the water out by gravity to lands which might be cultivated.

Period of development beginning in 1870 on Poudre River meant large and more expensive construction, building of larger ditches, long ditches and of course larger capacity because they were intended to supply larger tracts of land. The Greeley No. 2
2269 was designed to supply in the neighborhood of 25,000 to 30,000 acres of land as compared with 1000 to 1500 acres or perhaps less than that supplied by most other ditches. They were short of capital and at that time there was no means of bringing in capital. The credit of such enterprises was small and they had to depend largely upon themselves. In the case of the Greeley Colony I am advised that each colonist subscribed $100 as his fee to colony, which went for land and ditches. In many cases they constructed the ditch by actual labor instead of paying cash. Each one put in a certain amount of the labor. The problem was to do the construction with as little capital as possible. The headworks in such cases were simply what might now be considered

temporary. They were of lumber and could not have been constructed and the settlers could not have gotten a foothold if they had not been cheap. At that time the Forest Service had not got possession of all the forests. They simply could not have developed the country unless they could have developed it at a very small outlay.

The people who were the pioneers and were willing to expend their efforts, were people without money and without credit to any great extent, at least. Those who were required to borrow money had to pay a very high rate of interest. These headgates and structures were all built of timber or lumber and usually of very simple character but were such as met the needs. In many of these cases the actual outlay was only a few dollars per acre, and this was the case for even quite a good many years after that.

This led then to the forming of an organization which was rather that of a cooperative company or body. Sometimes such organizations were in form or company simply because of convenience in administration or division of burdens. The corporate
2270 form was simply for convenience. They were purely mutual companies, they were not organized for profit, but were simply the most convenient machine for performing services required. The capital stock in such cases merely stood for the respective interests of the farmers who were interested in canal. In most cases stock had a par value, but in some cases even that was not the case. They represented shares in the ditch and in the water that the ditch supplied. The stock was taken as a mere convenient evidence of title, and under some statutes in some states, some value had to be given to such shares of capital stock, so in some of these cases a par value was given because it was necessary by law when they organized as a corporation.

The lands under these ditches were in most cases taken up prior to the construction of the ditch. That is, the ditches were constructed by the people who had taken up land like in the case of Greeley Colony, the Longmont Colony and the Fort Collins Colony. The settlers were on the ground or they sent their subscription and assessment, whatever it might be termed, and some of the officers of the colony built these ditches and then these people came as soon as the land was ready for them. They used all the water they could get. In some cases perhaps the appropriation was large and the appropriations were made in terms they were not famailiar with, and they were feeling their way to know what should be proper and best.
2271 They were moulding the future laws and rules of administration pertaining to irrigation. This was decidedly the fact in the Poudre Valley. At that time there were no laws in the United States relating to irrigation. There had been no law relating to mining prior to 1866, and the same condition prevailed concerning irrigation. These early communities, especially this Greeley community, met a condition of affairs that was not anticipated by the laws then existing. They developed beyond the existing laws, and hence they felt the need of further statutes, and the statutes of Colorado have largely been developed as the need grew. This par-

ticular community is responsible for the development of irrigation legislation in Colorado and that legislation, in turn, has been the pioneer of most of the legislation in most of the other arid states. This legislation grew out of the needs of the irrigators, and not out of anticipation. It has always been true in Colorado that legislation has generally been behind the needs of the Poudre Valley. This valley has been in advance of the needs of other parts of the state. That is true even to the present time, because this valley has been about ten years ahead in its activities of most other portions of the state. I am generally familiar with these large canals con-
2272 structed in Poudre Valley and which began in about 1870.

In the entire valley there is not a single case in which there is a large body of land situated beneath a canal whose water supply has been ample where the lands have remained in a great measure arid, uncultivated, and in their raw, unbroken state, or where, when settlement has been commenced, it has been eventually abandoned and the lands allowed to return to their formerly uncultivated condition. Such cases are not found in my experience anywhere in the arid west where conditions are fit for agriculture, and where reasonable time has been given for development. By reasonable time for development I don't mean that the land will be taken up and occupied immediately the year following construction, but, in case of the Poudre Valley for instance, under the Larimer and Weld or the Larimer County Canals, it took perhaps a period of ten years to put all of the land under cultivation. I think all of the land had been taken up before that, but after that time there would be practically none that would not be under actual cultivation. In the case of the two canals mentioned the period was even less than I have stated. In the arid region where the rainfall is scarcely sufficient for independent agriculture, settlement follows construction and does not precede it to any great extent. It preceded construction in the earlier days to the extent in most cases that the settlers took part in construction of canals. They did not have independent means, as a rule, and they were settlers during time of construction of canal.

This was frequently the case in the west during these periods
2273 in the sense that they were building canals and had to build them without money. Frequently where canals are surveyed by other parties to irrigate lands fit for agriculture, settlement precedes actual construction. Perhaps as a whole this is generally frequent. Quite a large number of cases where prospective settlers are people who propose to take up the land and who do come immediately and wait for the canals to be completed and water to become available. This is quite generally true in case of reclamation projects by the United States Government. It is universal so far as the fact is concerned that there are instances on ever- canal, but it is not the case that it is true in every track of land under such canal, or by any means a majority.

Beginning 1870 there were a number of other canals constructed in the Poudre Valley on practically the same basis as those constructed by the Union Colony. For instance, there is the canal commonly known as the Larimer County No. 2 heading at Fort Collins,

the New Mercer Canal came in this period and was of the same general character, and the Lake Canal was essentially of this general character. I refer to the fact that they did not have to depend upon outside capital. Several other canals were constructed or enlarged during that time but were of generally a smaller size. This stage was not so much a condition or stage of development as it might be termed a stage of social development. The financial con-
2274 dition of the country was such that it meant not only their own financial resources, but confidence that people with money had in them and in the community, and which made them willing to put up funds for development, doing it as a commercial enterprise possibly. It is along that line that I distinguish between this stage and the third stage.

The third stage, the construction of canals by aid of outside capital is exampled by the construction of the Eaton Ditch or Larimer and Weld Canal. Construction of canals by capital from other sources began about 1880, although the Highline Canal near Denver and the Eaton Canal in the Cache la Poudre Valley, and one or two others were started about 1879. 1880 would practically mean the beginning of construction by capital from outside. This was the beginning of the third period. Of course, the two stages more or less overlap, but that was the time when outside people began to see that the development of civilization and development of the country was permanent. That it was not simply a mining country with a temporary life. It also indicated to people at large the results of irrigation were sufficiently remunerative to warrant expenditure of money. It meant that they were willing to invest their money and that they did so expecting to get a return from it.

Following these cases came the period in which people were willing to build even larger canals and expected to get their money by sale of water rights and possible sale of land and water rights and generally took up the project on a scale which it would be very difficult to do as a co-operative enterprise. In the cooperative enterprise it meant the land was in private hands, at least
2275 to a large extent, and that this large number of individuals must get together and agree upon a course. This was always surrounded with more or less difficulty. Conditions were such that longer canals were necessary and corporations of this kind had to be formed to meet the conditions. These corporations constructed the canals on contract for sale of water rights, and in many cases they obtained the land and sold the land and water together. They were able to do this, owing to the fact (in some cases) that lands had been granted to the railroads and they could secure these. Not very many of these companies made money out of these enterprises in the end, at least not those which sold water rights. Some of those that sold water rights and land together did, but many of these enterprises were not brilliant successes in a financial way. As to being successful in way of developing country, they have all been successful and the communities have benefited almost immeasurably.

The value of lands that has come in consequence of construction

of these canals has been a great many times the cost of the canals and there is no case in which the enterprise has not been a complete success. The original investors, when they attempted to sell water as a water right, did not do well, for the public as a whole was not inclined to pay for a water right anything nearly what it had cost the canal company. The land developed notwithstanding
2276 these financial obstacles. Developed constantly and very successfully. None of them showed evidence of abandonment either in settlement or cultivation. During this period of investment by corporations, the following canals were constructed in the Poudre Valley:

The Larimer and Weld, the Larimer County, and the North Poudre Canals.

These were the especial three along in that stage of development. Following the construction of these canals, settlement occurred with greater or lesser rapidity, depending upon success of bringing in settlers. In some of these cases they had vacant land and had to find purchasers for this land and their water rights, so that some few years were consumed in taking up the lands. Less than ten years were required by the Larimer and Weld for placing the lands under cultivation.

There was a lack of water under each of these canals in beginning. There was an acute situation under these canals. The pres-
2277 sure for water was felt at that time. When I first came to Colorado to reside permanently in 1888, the situation was more acute than it has been since.

This general period of construction of canals through corporate enterprise in the Poudre Valley practically ceased in the 80's, although it should be modified by this statement, that the same general conditions still prevail and the reason it ceased was because the larger supplies of water immediately available were exhausted insofar as expensive construction was justified and there were some water districts which would continue to rely on the development or consequence of the same general conditions.

The stage of construction of reservoirs followed the construction of canals by corporate enterprise.

This reservoir stage was due to other than finances of the community, at least very largely so. In the first stage we found individual activity. In the second stage we found cooperative activity. In the third stage the bringing in of outside capital and the construction of practically all large canals that were then available and now comes a stage due as a consequence of settlement and the pressure for more water, and need of water for late crops, and hence the saving of water which they had and which was going to waste more or less. This led to the development of reservoirs as a practical means of conserving the water supply and the using of it to the best advantage. In this case, the change of the value of lands led to the discovery of more valuable crops, especially potatoes, which
2278 call for water late in the season. They found that the water supply was short for that period. If they were required to

rely upon the natural supply from the streams they had to confine themselves to cereals and alfalfa.

In the 80's they had not begun to sow alfalfa to any great extent. It was also a period in which they were developing to a great extent the jurisprudence relating to water. Then came the potato growing period, the period when wheat was found not — be as profitable, and then came recognition that a great deal of water had been going to waste earlier in the season, during the natural flow of the stream that could be saved if they would build reservoirs.

Reservoir construction began in these different communities in the same manner it had with construction of ditches, that is, cooperative enterprises in the form of a corporation. They utilized the basins that were cheapest and most available and built storage reservoirs at some cost. They made assessments and proceeded to use their surplus of water that had been going to waste earlier in the year, in the winter and at other times.

The fourth period would be that of reservoir construction and would be a separate stage as distinguished from the others. It started about 1890 although two or three reservoirs were constructed prior to that time and it might be said to have begun in 1888 or in 1889. It has continued up to the present time. Simply economy and pressure for more water continues and in this case as in others, the same question, forcing the people at all times to be as economical as possible with the water supply. Just so soon as the people become more economical and they use the water with greater effectiveness, the water increases in value and they can afford to take other steps to be economical, and can get greater results. This has been the condition all the time in the Cache la Poudre Valley and will continue to be the condition almost indefinitely.

2278 With this development of reservoirs in Poudre Valley came another related development of identically the same general cause, that is the need of more water in the existing canals. Where they had reservoir sites that were convenient, they then have, of course, constructed reservoirs, but they were searching for water and reservoir sites when most satisfactory were constructed. But the same search for water caused them to look into the mountains and to investigate the bringing of water over the divides. This caused the more far-sighted and those of most constructive imagination, to bring water across divides where they saw streams on the other side flowing in other directions and more or less unused. Hence, from identically the same cause, they began to consider means of bringing water across the divide and as early as 1879, 1880, and 1881, there were some attempts made at the head of the Poudre River to bring water from Lost Lake of the Laramie drainage, to bring water from Michigan Creek which flows into North Platte, to bring water from Grand River, or one tributary of that stream into the tributaries of the Poudre. These inter-watershed diversions are identical or of the same character of development as reservoir construction. They needed more water and these were means to get it, and the extent to which the irrigator could go depended upon their need for water and their financial ability. A

few years later came the construction of the Skyline Ditch. This was the most elaborate of any construction of that character at that time and the owners worked the inter-mountain diversion along with reservoir storage and we now have The Water Supply and Storage Company, which was originally the Larimer County Canal as the most typical case.

2280 The effect of the construction which took place during these four epoc-s of which I have spoken was to use the water supply of the Cache la Poudre more effectively than previously had been the case. Each succeeding period diminished available — of the stream. And yet the water obtained from the stream constantly increased. The call upon the river increased but the scarcity was felt less with the increase of acreage than one would expect, owing to the economies that came into operation and that came with more successful management, with the preparation of the land and the changes that took place as the communities were irrigated. There has not been as much quarreling over water, or as much anxiety over water supply, I think, in the immediate past as there was 20 or 25 years tgo when the acreage was not half so large as at present. There has, of course been some new water coming across the divide, but that is relatively small when compared with the total supply of the stream.

During all these times the irrigated acreage has been constantly increasing and is continuing so to do, and yet the water supply has not been increased, except for this amount from across the divide, which does not account for all the development. The same quantity of water has been increasing in its efficiency to serve

2281 lands for reclamation. The area has increased two and one half to three times within the last 25 years. The valuations have increased many more times. I would not be surprised if the valuations have increased 10 times.

The Poudre Valley has now reached a period where the larger enterprises are almost impossible, because the supplies that come from the river are now those which come from the economies, and hence, especially with the development of this last enterprise, the Greeley-Poudre enterprise, the period of large development has probably been reached.

The Greeley-Poudre is in one sense a combination of the corporate and public enterprise. The incentive and initiation has been due to some people of large vision who needed the corporate form to get started. Then development was made by the irrigation district form in which the people who own lands become responsible for the development. In the latter case it is a public form organized under public law and is of a quasi-municipal character.

This sixth and last stage is practically the final stage of development in the Cache la Poudre Valley. The same pressure exists and there is another stage which has been developing during the last 15 years that simply illustrates the same tendency, and inasmuch as it will continue in the future as at present, it will result in a class of development that might be put somewhat in a different

2282 stage. I refer to and will speak of this stage as the cooperative stage. It is not the construction but something similar in

principal of development as reservoirs. It is the utilization of the existing water supply. Pressure or need for water caused construction of reservoirs. Pressure and need for water brought about this cooperation stage of development. Reservoirs served to store up and utilize a certain part of the water, and this cooperative combination has helped them to combine together and use the water to better advantage. The development primarily consists in this:—some of the reservoirs were, of course, either below or above the ditch that needed water. If the ditch was to fill the reservoir it had to fill one below it and when they turned the water out they could not use it. If they could use water from a given reservoir they had to fill it from a ditch above, or build an independent channel to fill it. That then developed a situation where one ditch could fill a reservoir below, but they could not use the water and it had to be turned out to another ditch which could use it. For instance, the North Poudre Ditch could fill certain reservoirs and their water would be available possible for the Larimer County Ditch, then again, the Larimer County Ditch could fill some reservoirs that would be available for the Larimer and Weld or the Greeley No. 2 Canal, and the Larimer and Weld could fill a reservoir which they could not use. This would be available for Greeley No. 2 or Greeley No. 3 Canals.

2283 Taking again the case of the North Poudre Canal, they had water in their reservoirs and they had to let water go by their headgates in order to supply the Greeley No. 2 Canal for instance. The water in their reservoir would be unavailable for themselves, and of course, it would be the most natural thing for them to wish they could take that water which was going past their headgate and replace it by water from their reservoir. This would seem like a fair exchange and same conditions obtained as to other ditches that had reservoirs.

That originated the system of exchange so that, for instance, in the specific case mentioned, instead of letting the water go by their headgate down the river to supply Greeley No. 2 Canal, the North Poudre Canal would take that out into their headgates and turn out a corresponding amount of water from the reservoir put into the stream between the headgates of the two canals. A diversion again by the Larimer and Weld Canal and the Larimer County Canal caused another and more complicated exchange. The North Poudre Branch would turn out water from their reservoir and the Larimer County Canal would take it into its ditch. In exchange for that water the latter canal would turn water out of their reservoir which would go down to the Larimer and Weld Canal. The Larimer and Weld Canal would take this water into their ditch and in exchange for that would turn water out of their reservoir which would go down the stream to Greeley No. 2 Ditch and consequently there would be a series of exchanges so that all of these ditches would work somewhat together and during this period of a month or two in each season, they use a special man to supervise the exchanges, to measures out from one to another and to cast up at the end of the year the water accounts, so that they can see how the water exchange has finally resulted. More than that, one system, like the North Poudre,

has constructed a ditch and reservoir on Fossil Creek. They could not fill this reservoir from this canal or utilize it in their
2284 ditch They however filled this reservoir and used the water thus stored to supply the Greeley No. 2 Canal and then take out a corresponding amount at the headgate of the North Poudre Canal. All this has not only brought about this system of exchange, but more than that has put in operation a general cooperative system. While there is a series of ditches with a series of companies, and independent corporations to some extent, with opposing interests in the call for water, yet the joint condition of development has pressed them into a common union in the way of working together and they then cooperate in this and various other ways, so that the result is a better and more economical use of water in the stream. It makes a great deal more economical use, less waste, much less water going by and hence means a greater efficiency in the application and use of water supply. I speak of the present stage as the cooperative period; as the pressure continues it will undoubtedly develop this system to a greater extent than it has to the present time. Just how far it will develop at any time will depend of course upon the extent which the land will justify it. The final development of the exchange system will not result in a gigantic combination or water trust. There are definite units and they are not united financially nor are they united in disposition of water. It is simply a form of operation so that the water is used much more effectively and with less loss. At the beginning some of the ditches opposed such exchange, and it required some law suits to settle the matter.

2285 The exchange system of water in the Cache la Poudre Valley has brought about a constantly increasing acreage. Crop yield is also increased.

The exchange system on the Poudre River has reached a complicated state. It meets the present state of developement very well. It is developing and changing every year. I think the general principle to be that the system will continue to be developed just as conditions justify. To illustrate, the Fossil Creek Reservoir of the North Poudre system is one used purely for exchange and they are able to use this water for delivery to any canal in the valley notwithstanding the fact that the reservoir is below most of the canals. The system of this company is largely one of exchange. The whole system of exchange is largely under supervision of the Water Commissioner who is a state official exercising police supervision of the distribution of water of the district. He distributes in accordance with the decrees.

The initiation of this system of exchange in the Cache la Poudre Valley resulted not only in a decision of the courts supporting it, but also led to the introduction and enactment of statutes legalizing it. The first case arose where one ditch took out water from the stream and replaced its equivalent for rediversion by a ditch lower down the stream. The lower ditch objected to the substitution. On trial of the case the court recognized the justice of the substitution and afterwards the legislature enacted a statute legalizing the
2286 exchange, as in so many cases in water litigation in this state. The customs have been started in Poudre Valley and after-

wards put in form of legislation affecting other parts of state. Briefly summarizing the stages I have given and which I think might be clear or important enough to distinguish as I have mentioned are:

First, the individual ditch practically limited to bottom lands;

Second, the cooperative or community ditch carried out onto the uplands, but done by combinations of individual practically without capital;

Third, corporate or company development on larger scale with outside capital;

Fourth, development that came with pressure for water and necessity for storing. In this stage occurs reservoir development and also development across intervening divides. The latter is parallel to the former and due to the impelling cause;

Fifth, general cooperation of ditch companies in their joint action in economizing water and developing it more effectively. The companies and not the individuals forming the units.

Sixth, an extension of the corporate form into irrigation districts. this is again a way of raising funds and being able to carry
2287 out an enterprise on a large scale.

These stages on the Poudre Valley are, as I stated, typical as a whole of the stages of development of almost every irrigated valley in the west. Some of these localities which began in more recent years have been practically able to omit one or two of these stages. The stages have either been short or development has gone without that particular stage. The Poudre Valley has not only been the pioneer valley in many ways, but has been typical of these stages of development as a whole. It has been earlier than almost any other valley as a whole. The people who came into the Poudre Valley became familiar with the idea of developing the country by use of water and later scattered all over the western portion of the United States so that the consequence or fruit of the skill of this valley has been shown in enterprises in all our adjacent states.

Referring to the Greeley-Poudre System, an example of the last or sixth stage, only the flood water of the Poudre River was left for the development of the land included in the district. It was that portion of the flood waters not already taken by existing reservoirs.

In the Poudre Valley, reservoir development consisted in construction on sites of the main river, that is, they have had to build inlet canals and naturally the capacity of these inlet canals is limited. They are constructed so they do not take all of the supply of the river. They could not afford to build them large enough to take all the water of the stream and as a consequence there is a considerable supply of water left remaining at times. Under the Greeley-Poudre System, there would then be a utilization of the surplus of flood waters that other reservoir inlets could not take or which
2288 is in excess of capacities of reservoirs. They will also be able to obtain water that is available at time of rains when ditches do not need it, or when, from other causes and breaks they could not take it. In this case it came to the utilization of water remaining in this stream and also to going across the range and obtaining water that might be available there.

The principal available supply of water from Poudre River consisas largely of the peaks of the floods. At times of the year during storms there is water available when other ditches are not prepared to take it.

The construction of reservoirs in the bed of the stream was the most effective means of serving and utilizing these remnants of the water flow of the stream. These reservoirs are very expensive and that is one reason why they have not been attempted previously. Naturally the farmers would construct the less expensive ones.

The available remnants of water supply remaining in Cache la Poudre alone would probably not warrant the construction of these reservoirs. Hence, in the Greeley-Poudre System, the general conditions caused them to search for water supply for large body of available land and this general idea is the inception to a great measure of our enterprises. The storage of the peaks and surplus water was one source of supply. The other was the possibility of bringing water from Laramie River by construction of a long tunnel.

2289 The Eaton Canal or Laramie and Weld Canal, construction of which commenced in 1879, experienced a feeling of shortage of water for its consumers. That shortage continued throughout its history and up to the time of the construction of its reservoir. The shortage became acute. It was the cause of considerable litigation between this and other ditches, regarding water rights, and between users in that canal, who have different forms of water rights. In one way or another it has been the cause of quite a number of suits that I recall. For a number of years there was a constant contest for a sufficient water supply. This contest ceased about 15 years ago, during the period of reservoir construction. Relief came largely with building of those reservoirs and increase of capacity. Also by the inauguration of a system of exchange. It is true that that canal was short of water for long periods of time during each irrigation season for all of the years previous to the reservoir construction. It was shut down for considerable periods each season. Notwithstanding this, the development has constantly proceeded and the part 15 years has been more active than before. The people under the canal have been quite contented and their disputes, I think, are practically

2290 all settled, and the supply of water is now such that the crops are in splendid condition. It irrigates a very rich section of agricultural country.

It is the rule with canals in the Poudre Valley not to permit water to waste out of the lower end. It is used by lower ditches and there is practically no waste at present time. That did not use to be the case. The individual irrigator arranges his irrigation so there is practically no waste. If he does waste his water it is caught up in a lower ditch, and if he habitually wastes it the ditch rider cuts him down and cuts off the excess.

Waste of water is prohibited by law within Colorado. There was more waste of water in earlier days. There is a provision of law requiring the returning of water to the streams. None of the canals in the Poudre Valley turn their water into waste lakes where it is

absolutely lost. Development has been such that individuals waste practically none. The small waste means very close supervision. This means expense, with night irrigation and night supervision.

2291 These all come with the development of the country and that has been a development of this valley.

Very close supervision is given the use of water in irrigating potatoes, beets, cabbage, onions and other late crops. The water is used very economically. It is followed day and night. This is also true of irrigation of other earlier crops. The custom is constantly growing and in some cases people avoid attention during night by turning it on tracts where irrigation can proceed with advantage without much supervision. In other cases they go out several times during the night. This varies according to immediate situation.

Irrigation practices in Poudre Valley have developed class of laborers whose business it is to apply water. Many of them are very skillful, having become acquainted with different tracts of land and know better how the water will run and how it can be made to reach special places. The whole result is one of increased efficiency.

Nearly all the larger enterprises in Colorado have come from Greeley in first place. That is, you will find, in tracing history of almost any of the larger enterprises, that the people active in them came from Poudre Valley after having been there for some time. For instance, the Highline Ditch near Denver, sometimes known as the English Ditch, both the chief engineer and the constructor, Governor Eaton, were from the Poudre Valley. In the Arkansas Valley you find the Fort Lyon Canal laid out by Mr. LaGrange from Greeley. The Amity and the Colorado and Arkansas, on the south side of the river, were developed by Mr. Nettleton who was at Greeley an original colonist, and his locating engineer, Mr. Duvall, who has testified as a witness in this case. In the Montezuma Valley each of the canals built through the divide from the Dolores River into the Montezuma Valley were projected by Greeley people. Go up into Wyoming and several from the Cache la Poudre Valley are found under the Wheatland Canal. In the region of Sheridan, Wyo., you will find the Fort Collins Canals. In Utah along the Utah Lake a gentleman from Greeley was active in the development. This is generally true throughout almost all of these western states. Likewise in New Mexico, Texas and Montana, a little investigation of history of various enterprises will reveal the fact that Greeley or Poudre Valley people had a great deal to do with suggesting development or perhaps furnishing one man or men

2293 who were active in it. The same is true of Australia. Australia sent their commissioner here in 1884 and obtained several men for a system there. The State Engineer of Wyoming, who was very active in their development, Mr. Mead, was in Colorado for several years, and Wyoming took the Colorado laws with some modifications. The list is very extensive and undoubtedly is much more extensive if one knew the history of each enterprise. We find it in Western Oregon, Idaho, and I have had to do

with some cases. Also in Nebraska, Kansas and Northwestern Texas.

In the Laramie Valley in Wyoming, in part of it at least, some people who had been in Colorado made some attempts at development. I think the idea of the Wheatland Reservoir originated with a Colorado man, Mr. H. E. Johnston, who was taken to the Wheatland enterprise from Colorado.

The Cache la Poudre Valley is typical of other valleys throughout the country.

Direct examination continued.

2294 By Mr. Delph E. Carpenter.

The development of the reclamation of lands of the Poudre Valley under the canals I have already described, having been within the present memory, has made some physical changes very evident. One of these is the filling up of the subsoil. In 1870, when the Greeley Colony was started, there were probably not more than 10,000 acres of land irrigated in the valley. That was estimate made by one of colonists. This land was all contined to bottom lands. During next 10 years area became approximately 70,000 to 80,000 acres. In 1890 there were 135,000 acres irrigated. That was estimated based on the best information I could obtain, and which I made for United States Progress Report on Irrigation published in 1891. That is Senate Executive Document 53. At the present time there is approximately double that acreage irrigated.

At beginning of irrigation, as in all this western country, water was difficult to obtain by means of wells. It was practically
2295 at bed rock and then only in small quantities. In building the Greeley No. 2 Canal they did not have enough water about a mile below the headgate to water their stock. They had to drive their stock to the river. All through that tract of land the depth to water was practically the depth to bed rock. They could not obtain water enough from wells for their animals.

Bedrock seemed to run from 30 to 75 feet. More commonly 50 feet and over. After irrigation it was found that the water was nearer to the surface, so that all through that section of country instead of 30 to 60 feet it has come to 5 to 15 feet from the surface and in some cases to the surface. Where the town *or* Eaton now is, it was originally 54 feet to water. In 1890 it had become 16 feet to water. I do not know present depth, but presume it is about the same. Where Greeley now is I believe it was originally even more than that. At the point I previously mentioned a short distance below the headgate of the No. 2 canal it was originally 40 feet to water. At the Baker homestead it was originally 20 feet to water, that is, they dug a well 20 feet deep and got no water at all. In 1894 at this point the water was at the surface. This place is located a few miles north of Greeley. South and east of Lucerne, one Hopkins went still deeper for water. In another place he went 35 feet and in the course of a few years the ground water was within ten feet of the surface. There are number of instances of this kind. Wherever facts are ascertained it is demonstrated that practically

whole country is filling in to depth of less than 30 feet, as an
2296 average. In some places underground water has risen 50
and *and* in some places not more than 10 or 15 feet. I think
30 feet on an average is rather a low estimate. The ground water has appeared at some places on the surface. This appears in depressions and draws. These traverse Greeley country. They run in same direction as tributaries, nearly at right angles to stream. They cross the ditches at right angles.

The effect of irrigation has been to convert this arid country into a country somewhat analogous to the east. In the east the rainfall is more than is lost by evaporation, there is a surplus which goes into the ground and the ground is more or less filled and it contributes to draws or water courses and the streams are increasing constantly as you go down the stream.

In this country, with relatively low rain fall, the reverse is the case. The draws are very dry except in times of floods, but as the country was filled in with this excess water from irrigation, it raised the ground water or water table and this would be higher than on ground under the ridges than in ground under the draws and so it would be near the surface of the draws. It might be absolutely at the surface.

A great many of these draws which were dry have now be-
2297 come running streams from seepage water. That is the
visible contribution from the underground lake that has come from irrigation. That change due to irrigation is found throughout all these irrigated sections. It means that the water in the river itself has tended to increase. That is, the Cache la Poudre River has tended to increase rather than decrease throughout its length. The same is true of the Platte.

The rising of the underground water plane has not decreased the necessity of irrigation. It has decreased necessity of so much water for irrigation. This applies to the portions in draws or bottom lands that were near water table beneath. In some cases they became so wet that drainage became necessary instead of irrigation, and the conditions varied all the way from that to the place where the full amount of water is still required and consequently on the average the need of this ground was very much reduced.

A very small proportion of the land of Poudre Valley is seeped. It occurs mostly on the original bottom lands and some of the draws. This seepage is the natural consequence of irrigation and is found wherever irrigation is practiced. It has occurred in San Luis Valley where it has been termed sub-irrigation. The phenomena is the same but the plain is so uniform it does not appear in draws or ravines but comes uniformly. It had the effect of destroying the land or crops in some places. Water in Poudre Valley did not have that effect to any great extent, because ravines served as drain-
age channels, and served to drain it before it seeped a very
2298 large area. Such land, while frequently spoken of as be-
ing destroyed, is simply temporarily injured by excess of water and can be and is frequently reclaimed by drainage. A great deal of the land in the lower depressions or irrigated land in the Cache la Poudre Valley has been drained. The area that remains

is relatively small. In the older countries, India, Italy, etc., where irrigation has been practiced longer, they have not known what the original condition was and so the effect could not be observed. Again, the Cache la Poudre Valley becomes typical of this feature of development. It shows the changes that might have been missed by lack of records. It is evident that the water required to make this underground lake, has had to come from water supplied to the surface.

There have been other changes which might have come partly as a consequence, not so marked as that. These perhaps are not such as might be classed so much as physical changes due to natlral conditions, but simply to development. For instance, the lateral system or method of irrigation. Application of water has been with skill, and with knowledge of the lay of the ground so as to lessen the loss of water and increase its effectiveness. The skill of the ir-
2299 rigators has been increased. Management of canals and a great many other things of like character have been changed, so that the human element becomes quite a large factor.

The Cache la Poudre Valley has become almost a solid cultivated area. It is a country of homes, of rich farm lands. It has now become a country where the houses have all the appearance of prosperity. They are of brick, two stories, electric lights, telephones, etc., with the adjuncts that go with prosperous country places. The farms have largely been broken up into relatively small tracts to 40 to 80 acres, and it is practically one solid mass of cultivation.

Originally the country was barren and without trees. The colonists set out trees as one of their first steps, especially along roads, borders, and ditches. The country now is a wooded country. In many cases the first crop of trees has matured and been cut down, this is the case with cottonwoods. They became old and began to decay but the country generally has the appearance of a wooded country. The cottonwood is a native tree. There have been quite a variety of trees planted but the cottonwood is prevailing. It is a tree of quick growth, hardy, resists the attacks of insects, and is very certain to grow with little attention. While it is objected to, to some extent, it has been a very popular tree. The box-elder is a native tree of the valley. They also have growing, ash,
2300 elm, locusts, and in fact almost all the trees of different varities that will grow at this latitude.

Orchards of fruit trees have been planted to some extent, more as you reach the neighborhood of the foothills.

I have never seen any part of the United States that gives as favorable impression as does this country in its present state of development. There might be some parts of Illinois and some parts of New York and New England that compare with it in some respects, but the portions I have been through in detail with teams or automobiles have been so rough that they have not had an area that would compare with this. There might be some tracts. The area of this valley is more uniform and comparatively smooth and even without irregularities. Practically all of it is under cultivation. The area gives that appearance of crops and richness. I have not

been through Western New York. I have heard of it, but have not been through that way.

During time I have been engaged in practice of my profession in Colorado and elsewhere, have had occasion to make study of subject of duty of water. In work in connection with Experiment Station, that is the Agricultural Experiment Station maintained by funds from Congress and called either the United States Experiment Station or the Colorado Experiment Station, I took up the
2301 duty of water as one of the subjects of investigation and made some investigations quite a number of years ago and published a report. I think it was one of the first reports printed on that subject. It was the first so far as I know. That was Bulletin 22 of the Experiment Station and must have been issued about 1893. Incidentally I carried on experiments and investigations and made examination of all different tests and experiments that I knew of anywhere in this country or abroad. I have always kept up, or attempted to ascertain what might be called the duty of water.

The term, "duty of water" has several different significations as commonly used and one prevailing one has been given, especially at the beginning of irrigation of any section, and is found almost everywhere at beginning of development of country. With other developments that come with economy of use, with reservoirs, etc., it has rather a different meaning than as originally used. In the one case duty is commonly expressed as the relation between the number of acres irrigated and the flow in cubic feet per second. The other way of expressing it is as the depth of water that has been applied, and very frequently the use of the word duty in the latter case is avoided because of confusion and ambiguity. Thus in the Poudre River Valley, originally they made comparisons on the basis of 1.44 cubic feet per second to 80 acres and that form was very common as the duty at that time. That was really equivalent to enough water to cover 80 acres 6 inches in depth every two weeks.

2302 It is a convenient form of expression to use cubic feet per second for a given area because it is an item of information that is wanted by the constructor of the ditch, by the farmer, and by the ditch user or superintendent. It gives them a means of knowing how much water should be turned out. As used in this way, is rather an expression of the maximum amount of water to be turned out. That might again be expressed as the average flow, which again would be different from that result.

If the other expression of depth during the seaosn, be taken, then the element of time has to be taken into account. In the first case, of for instance 1.44 cubic feet per second is equivalent to 6 inches in depth in two weeks over eighty acres. As a matter of fact, users of water would not use that water continuously at any such rate. They would use it at such a rate perhaps for two or three weeks and then the demand would drop off to a much less amount. I refer to agricultural methods on agricultural crops. The individual farmer would not use that flow as an average quantity. Thus in May he might use very little, June might run to the maximum, July might

drop down very much. The time that the water had been used would be a very essential element. If it were to run for 98 days for instance, it would be equivalent to 3½ feet depth of water. If used for less time, the depth would be correspondingly less. While it has been a convenient method of expressing it, it has not been a very exact method. It has given a means of knowing how large a ditch would be required to furnish water for a given tract because the ditch would have to furnish enough water at the time that the growing crops needed it most, and not simply to supply the average quantity.

With development of reservoirs and pressure requiring use of every bit of water that there is in the unit, it has become con-
2303 venient to express water in depth, and especially since reservoirs have been constructed. For instance, there would be 10,000 acres feet in a reservoir and that would then supply 10,000 acres one foot deep, or 20,000 acres six inches deep. The size of the stream that would be taken to supply this quantity would vary according to the rate at which it was demanded. But even in those cases they are required to figure out the size of the stream called for.

It might be well to mention here that the relation is fairly simple between the size of the stream. A stream running one cubic foot per second would supply in twenty-four hours almost exactly two acre feet. The discrepancy is less than one per cent, so that for common purposes it is a convenient ratio.

It has been customary in Colorado to fix the capacity of reservoirs and the water stored in millions and fractions of millions of cubic feet. The law requires that capacity be expressed in cubic feet. In large reservoirs, millions of cubic feet are convenient to engineers. They also express the capacity in acre feet, which is more convenient.

There are 43,560 cubic feet in an acre' foot, because there are 43,560 square feet in an acre.

An acre foot of water is enough water to cover a superficial acre one foot in depth. As an acre has 43,560 square feet, an acre foot would be 43,560 cubic feet.

The cubic foot is used as a unit of measurement of stored water. The cubic foot per second is used as a unit of measurement for flow-
ing water. The cubic foot per second is a rate of flow while
2304 a cubic foot is a quantity and has no connection with time whatever.

A cubic foot per second would produce 60 cubic feet in one minute, 3600 cubic feet in one hour, and 86,400 cubic feet in one day. The quantity would increase with time. It is a measure of rate of flow while the cubic foot as a quantity is independent of time.

The acre foot likewise is a measure of quantity and it does not have any connection with time so far as the unit is concerned. It is not a measure of rate.

A stream flowing a cubic foot per second would give a cubic foot in one second. The relation between a cubic foot of water and a cubic foot of water flowing in a second of time is corresponding between that say miles and velocities, or miles per hour, for

instance in speed. That is, a mile is a distance while a mile per hour is velocity or rate.

There are 23 acre feet in 1,000,000 cubic feet. It is of course as many as 43,560 contained in 1,000,000 or in round numbers about 23.

Speaking of unit of figures, 1.44 cubic feet of water per second of time as used as a standard of contracts in certain irrigation systems in early days, there is a similar unit used in Wyoming by statute. It is expressed in the reversed way, that is all. In the case of this unit, it appeared in the early days. 1.44 cubic feet per second of time for 80 acres, which was made the basis of contracts in the Highline Canal near Denver, Laramie and Weld Canal and other canals. That, then, is equivalent to 55.6 acres per cubic foot per second. That unit was used for their in-
2305 formation. They then had it fixed at a sum they thought would be sufficient.

In Wyoming the statute has fixed 70 acres per cubic foot per second as a basis for their decrees. In their contracts this ratio is then used. This unit of 70 acres per cubic foot in Wyoming and 1.44 cubic feet for 80 acres in Colorado, is a maximum measurement rather than a constant flow. It is often stated as a constant flow but as a matter of fact it is not. The idea of many users is that it is a constant flow, but every one of these contracts is limited by beneficial use, that is, they are entitled to a stream of water not to exceed that amount and the proviso is read into the condition, so much as they can beneficially use or need. As a matter of fact, they cannot use that quantity ordinarily, so it is really the measurement of a maximum amount they can draw at any one time.

In practically all cases, whether so provided in the contract or not, users were all on same basis and if there was a shortage the water was divided among them. Many contracts did provide that in case of shortage they were entitled to their proportionate part. The contracts in the Colorado practice were simply preliminary contracts that came in the third stage of development concerning which I have just testified, where they were organized as companies and contracts made with users. Later nearly all these canals were put in form of mutual companies and in that case the stockholder was entitled to his proportionate share of the total amount of water in the canal.

2306 Wyoming statutory maximum of one cubic foot per second of time for 70 acres of land does not carry with it any limit of time. The only limit is that caused by conditions of irrigation season. In long season or long demand, the absolute quantity is increased and in short season it is decreased. That unit of meaurement simply applies to present diversion at any one particular time. It is practically the maximum quantity. I suppose it would be in legal effect the same as it is in this state. We may have ditch here, for instance, with decree of 100 cubic feet per second, or 500 cubic feet per second. That means the ditch may draw that amount but if it does not need that amount it cannot

draw it. It must remain in stream and is available for others later in right and time. Need of stream is fluctuating amount. By need I mean the amount they can beneficially use for current application.

Most reservoirs of Poudre Valley followed in point of time the construction of ditches in that valley. These reservoirs fill to some extent in winter. They fill in spring before ditches call for water or call for all the water. Or they fill in fall to some extent and at flood seasons during the summer. In fact, they fill whenever there is amount of water that is not being needed for immediate application to lands. They take water that otherwise would go to waste.

2307 The decrees for reservoirs in Colorado are generally expressed in either million cubic feet capacity, or in depth in reservoirs. The depth in the reservoir is measured from a definite point and gives quantity in reservoir, which is measured by physical conditions, whether it is so stated in decree or not. For illustration, I think the Terry Lake has decree for something like 29 feet. In expressing the quantity in that way it simply gave a figure that would be more easily observed or checked.

The term "duty of water" may be used in either of two senses. Commonly used as one expressing relation between the acreage served and amount of water, as so many acres per cubic foot per second. Same meaning is contained in statement of so much quantity per unit of land, as 1.44 feet for 80 acres. These are both expressed in same unit or in same way, except that one of them is using a unit of cubic feet per second and other is using a unit for 80 acres, but they are exactly the same in character. That is rather an expression of maximum quantity of water—maximum rate. Average duty under such conditions would be average flow for season which is practically not a very satisfactory unit. The other expression of depth is one that is increasing in use and will continue to increase in use with development of country, that is of stating how many inches or feet in depth the water is applied or needs to be applied to any tract of land.

As commonly used, "duty of water" means the size of stream that a unit of land can legally call for. With ditch men it is being to some extent superseded by other ways of expression.

2308 "Ultimate duty of water," would mean the amount of water that the plant itself may use in its own growth. I so used the expression in Bulletin 22 as the measure of that duty. When we speak of duty of water in ordinary ditch management it includes all waste incident to loss in canal, loss in measurement, failure to use, evaporation from soil, amount disappearing in soil by absorption, etc., seepage in canal and is very different than ultimate duty. One who attempts to compile results of duty of water as measured in this way, either by units that canals use in their contracts, or even in their depths, finds results that are very inconsistent and such that he can scarcely reconcile them, largely because of way of looking at them, and in the ultimate duty, that comes back to pretty nearly the constant term.

Various plants require different quantities of water within certain limits. Stating it in a general way, it may be said that a pound of produce of any kind requires in round numbers 300 pounds of water in the plant economy. That varies under experimentation both between different crops and under different conditions, different methods of treatment, and ordinarily whether they have been accustomed to such treatment. Other experimentors find dif-
2309 ferent figures and that figure has been accepted a good deal and seems to be a fair measure of the amount required. Thus a ton of hay has used in round numbers 300 tons of water and everything in excess of 300 tons of water has either been unnecessary or has been ineffective in the sense that it is not applied to the direct needs of the plant. Some may be necessary in distribution, some may be lost in carriage, some lost in evaporation from soil, and all the other elements of waste will add to the amount of water that may have to be applied or taken in by the ditch or consumed by the farmer. The farmer can economize in all other sources of loss but when it comes to the plant itself he cannot cut down the amount to any extent. This amount of 300 tons of water for one ton of hay, for example, if applied to an acre of ground, would mean that a ton of hay per acre would require 300 tons of water per acre as used by the plant and that measured in depth would be about 3 inches; 3 acre inches. That gives rise there to what might be considered the ultimate duty of water.

You can economize on the other waste of water as used, but you cannot eco-mize on what the plant itself uses. The ratio is approximately the same in most plants, wheat, etc. Individual tests run below and above. So that, a yield for instance of 3 tons of hay per acre would have used approximately a depth of 9 inches of water; 9 acre inches. Not 9 miner's inches but 9 inches in depth. If the yield be one-half ton per acre that would correspond approximately to depth of water used of 1½ inches. This is all dry matter, so that in the case of sugar beets, for example, when they speak of a tonnage of 10, 15, or 20 tons, that tonnage is not a dry matter but the wet weight, the weight with the water still in it, and this ratio would need to be based on the dry product and not on the gross weight before the water is evaporated from it.

2310 Alfalfa probably produces as much weight as most of the crops we have, and that could be considered as between 3 and 5 tons or probably the average is not more than 4 tons per acre. That is for air-dried alfalfa hay. We would not take into consideration weighed grain. We have straw and the grain itself, but in that case the weight is almost always in the grain, and the weight of the straw is not often known. For that reason I mention alfalfa owing to the fact that from the character of the crop we do know gross product. In case of wheat yield of 50 bushels per acre wou'd be 3,000 pounds or 1½ tons and to that would be added the weight of the straw.

Native hay would be the weight of hay produced, ½ ton to ¾ ton per acre is commonly found. In round numbers that would be equal to 1½ inches for each ½ ton per acre, to 2½ inches for

¾ of a ton, or 3 inches for 1 ton per acre. I am still referring to acre inches, owing to fact am using acre for unit of land upon which crop is raised.

2311 While speaking of "duty of water" I have not given the term the same as if I should start out and give what might be a definition but have given what is commonly understood as meaning of term. The term has different meanings in the different locations, and in same locality as well. I prefer the definition as it is used in expressing a measure of depth of water. I have mentioned the fact that that is the tendency that is coming among engineers in all parts where reservoirs are in use, that is, the depth of water on the land rather than the size of the stream, but that may be measured like the size of stream either at headgate, the end of ditch, or in river. Hence the place where it is measured needs to be specified in order to make comparison. This finally gives means of estimating or determining the economy in the unit as a whole by comparison with water resources in acre feet; for instance, it shows the extent of loss or waste and ineffectiveness, and hence suggests the economies that may come.

All the definitions that I have given employ the term "duty of water" as used to imply service water will perform in irrigation of land; but the term is expressed in so many different ways that they are scarcely comparable.

2312 By "increase of duty of water" is meant that in time in most communities larger acreage is served by same quantity of water. Hence acreage is increased and that means that stream serves larger acreage during time it is running. It is also true that depth of water required during season is less than formerly. That is phenomenon that is noticed in nearly all these valleys.

I previously described the rise of water plane in Poudre Valley and creation of additional supply on proably 300,000 acres of land and likened that increase to underground lakes. The spaces in the soil amount to practically ¼ of its volume. The volume of these interstices range from 30 to 40 per cent and on the average may be counted as at least ⅓. Hence, if water has filled up subsoil to depth of 30 feet, which it has done in Poudre Valley, that would be equivalent to at least ¼ of that depth of solid water, that is if soil were removed that 30 feet of saturation would give in the neighborhood of 10 feet of solid water. It would make a lake of that depth. The soil that is filled does not require re-filling. That body of water has gradually accumulated from water that has been applied to surface. It is the surplus. That amount of water has been applied over and above the quantity required by plants or needed for other losses or wastes, and hence, in course of practically 30 years there has been approximately 3,000,000 acre feet of water gone into subsoil. That would make lake 10 feet deep over 300,000 acres. This water now forms fairly stagnant body. It is in slow movement down hill whichever way the slope is. The movement is very slow compared with the surface flow. The law of

2313 its flow is different except that it flows down hill and runs in around number from 1 to 2 miles per annum, in places

it is considerable more. That does appear in these depressions, draws, arroyas and in the main stream. Where it appears in arroyas as well as in the main stream it is very frequently used again. There are many seepage ditches in Poudre Valley that depend entirely upon seepage water. Their appropriation is from these draws that were formerly dry and there is a claim for seepage water. The larger ditches crossing these arroyas pick up seepage streams that come down the arroyas. It forms quite a considerable contribution to main supply.

Practically all of surface waste water as well as seepage water is conserved and reused in Poudre Valley. All of surface waste that comes from ditches is used. In early days there was considerable waste from that source. There is practically no waste from that source, either individually or by communities. That has come with greater skill in handling water. I may state that there is a condition that at first somewhat puzzled me. I found individuals were wasteful while community was very economical. Reasons for that, however, was that the loss of the individual was captured and used again by other ditches, so that we have the fact that the community may be relatively economical and the individual might be
2314 wasteful. At the present time individual has more skill as a rule and much more familiarity with his land and individual application has decreased.

Water flowing in Cache la Poudre River as it passes out of mountains and begins to enter canals now serves much larger area than formerly. In 1870 it served 10,000 acres. In 1880 probably not more than three or four times that quantity. In 1890 about 130,000 acres. It now serves 260,000 acres: the same stream flow serves the latter acreage that served the first acreage given. The water stored in reservoirs is merely part of the stream flow so that the peak part of the flow has since decreased, is stored in reservoirs as has also the waste at other times. The acreage served has been very much increased. For all purposes it is substantially the same water now as it was 20 or 30 years ago, with these changes in methods of use, matters of economy and conserving water. The struggle over water and pinching caused by shortage is much less than it was 25 years ago. The increase in acreage has occurred almost entirely on north side of valley. This has occurred because lands were available there. On south side of valley, a few miles east of Fort Collins a ridge extends out that confines irrigation from south of Poudre almost entirely to mesa near Fort Collins. This mesa is north and west of Fossil Creek. North side of river lies so that water can be brought out to it, and in that time there
2315 has been further utilization of Laramie and Weld and Laramie County Ditches, North Poudre Ditch and extensions of these ditches and also extension of Greeley No. 2 Canal. In case of each of these ditches the land, especially near headgate, became more or less saturated. The ground water came near enough to surface so that it needed very little irrigation and perhaps needed drainage instead of irrigation. That land, if not abandoned, was in situation where it would not need irrigation. They then transferred right to use

that water to other lands lower down and so ditch did not run any more water but it brought under cultivation more lands towards lower end of ditch.

Did not increase its demand on stream in making extended reclamation. This extension was by means of extension of main ditch or by formation of lateral companies and laterals which might run our 5, 8, or 10 miles and were in effect an extension of main ditch. By this means this land has been brought under cultivation and has had the effect of largely increasing the total acreage. These were mutual ditches, so that owners living near head who owned ditch stock have nearly all divested themselves of that stock.

I will distinguish between Colorado plan of water rights and its relation to land and Wyoming plan. Under the system that has grown up in Colorado, the mutual ditches, the ownership of a share in a ditch meant the control of a certain fraction of the water. Water was delivered to possessor of share of stock without distinguishing where lands of its owner were situate, whether it be at lower end of ditch or somewhere else. This permitted
2316 to a greater or less extent, natural development that follows natural economy, so that person who had more shares of stock in ditch than he needed to supply him with requisite amount of water, could dispose of portion of his stock ownership; for reason already given and other reasons, his demands for water decreased to a greater or less extent. Less water would be needed by his tract of land. Where perhaps 10 shares were needed to supply him originally in many cases 5 shares or some other number might suffice after a series of years, and in that event, he would or could often sell his extra shares of stock. This would naturally go to lower end of ditch and really increase the total acreage, but would not increase the amount of water that the ditch was using. That has been one of the practical workings of this system in Colorado. The mutual ditch system operating in that manner has tended to facilitate the reclamation of land.

In this Colorado system then, water was not confined to a particular tract of land. It was assigned to the ditch and the land under it, but it has lent itself to this expansion and this economy that is a natural consequence of irrigation development we see in any irrigated country.

Under the Wyoming system, I understand, the water is limited to a particular tract of land and the particular section or particular eighty of that land in the permit is described so that water is decreed to that particular tract of land and no other. The owner of that land then, has no particular inducement to economy because he does not get the advantage of the expansion. If he uses less water, the condition is that the quantity in the ditch or in the stream is possibly increasing, but as he does not get the benefit he is not constantly pushed by the incentive that prompts economy and that is of getting more benefit himself. This system, therefore, does not lend itself so well to a growth of this kind of develop-
2317 ment and to a greater economy. Activity in that regard is very largely increased by selfish benefit. That is, greater

economy or greater use of water or extension of use of water has come from various causes, but practically the recognition of the benefit of economy has come only under necessity. I mean this:—that on the ditch where there is plenty of water or on a farm where a man has all the water he thinks he needs, he is not going to economize. He uses water in place of cultivation and uses it a great many times when it is not necessary. My observation has been, and I have had quite a good deal of opportunity to see it in going over this Poudre Valley and other parts of the state in detail with horse and buggy and a great many times, and in discussing the matter with these men, that nearly always they have first been convinced that less water could be used successfully after they had been pushed to a condition of economy. For instance, an extremely low year, or an accident to a ditch, has shut them out and they have frequently found that instead of crop failure they have had better and more crops than some neighbor who had more water. That has been the case in many instances that has convinced these people that they can get along with less water and that has been the beginning of our economy. They have had the lesson pressed upon them rather than its being one of intention. That has been true, I know of quite a number of instances under the Greeley No. 2 Canal, for instance, and other ditches, but in almost every case unless
2318 there is some constant pressure of that kind, a pressure even of canal officers, they are not going to get the best use of the water. Of course losses or even reasons why water is used in greater quantities are some of them semi-necessary, some, principally, unnecessary. There has been mentioned the great quantity of water that has gone to fill subsoil, that is not now necessary in Poudre Valley. I have seen in Poudre Valley some tracts of land which were shallow, with no irrigated land adjacent, and they would use 4, 5, or 6 feet in depth in that case. Lots of water was being applied and going out to fill up sub-soil in adjacent land. If lands near were irrigated, amount of water would not be so great, because it would practically only have to fill the subsoil beneath. Loss in ditches themselves, that is, after the water is measured into canal at headgate, or as far as whole community is concerned, loss from headgate and lateral is considerable. Loss in lateral, loss due to measurement in water owing to inaccuracy, requires that ditch rider gives enough so that user will think he has what he is entitled to.

There is less waste individually after a man becomes acquainted with his field. At first his knowledge of field is new. He turns water out in an amount and after a time that probably will cause water to fill up at lower end, run through the rows and across the field and waste. He learns after a while what size stream is required, how many hours it will take to cross his field and of course with
2319 an experienced irrigator or careful man, his object is to prevent any such waste, and as he gets more skillful, and acquainted with his field, that decreases more and more, so in some of these communities there is practically no waste from this source. One of the greatest differences is in the change of character of sur-

face. It requires a depth of 3 inches to irrigate a tract of land. When compared with good rain fall that amount seems extravagant, and, in a sense, it is. The need is not that of the plant alone. They cannot distribute a less quantity and that is the physical problem of spreading it. If ground is more or less uneven, rough, with little hommocks, ridges and prairie dog mounds, and ant hills, etc., other like irregularities, they practically need to get nearly as much water as the amount given on the summits of these little mounds and the effect is that they get a great deal more water than that in the depressions and hence, when the field is rough, the problem of uniform distribution is that the common or average amount is much in excess, 8, 10 or 12 inches is taken often for single irrigation. As irrigators become accustomed to their fields and know how to run their laterals and distributing ditches, as they smooth their places from year to year so that it might be compared to an inclined *plain*, which is case in many instances, they lessen the amount that is required for purpose of distribution, they bring it down to depth of possible 3 inches, sometimes a little less. This then, results in great source of increase of efficiency of water. These sources come in as country gets better accustomed to water, as subsoil is filled, as management of ditches becomes more efficient, as users
2320 operate day and night, as they will do when water is more valuable. Irrigators do now operate day and night. As land gets smooth it can very readily be seen that same amount of water will go very much further. A great many irrigators have a man to distribute water by night as well as by day. Where they do not keep a man active all the time, they generally have means of setting it so that it will continue its irrigation during the night without waste.

Failure to distinguish between these conditions explained great discrepancy in depth. Limits of measurements from different places can be obtained that vary all the way from a few inches of a foot in depth up to even 2,000 feet in depth. That amount has been used on a tract of land. 2,200 were used on a tract of land in French Alps under management of Herve-Mangon. Of course that land was pretty nearly a sieve and was used for hay. But with cultivated crops, they are within much more moderate limits, but still frequently run up to 10 feet in depth. This may be measured either at headgate at ditch or outlet headgate at stream. I do not believe distinction for most purposes is accurate enough to make any great degree of refinement necessary there. Final comparison would really be made final with what plant requires and that in excess of plant requirement might be lessened or reduced to a moderate limit, so that when it runs up to any such amount as several feet, it means that there is a great deal of waste going on somewhere.

Expense for smoothing is justified or not according to value of land and general economic conditions. The crops to be raised give
2321 the land its value. If it is land worth $20 an acre, it will or will not justify a certain expenditure. If it is worth $100 per acre, the expenditure which could be made would be absolutely

unreasonable if made on $20 per acre land. In such a community, land is liable to increase in value, which means that more labor and expense can be put upon it. Aside from much expenditure for such purposes, the land is plowed and cultivated from year to year. They frequently go over it with this in mind, so that they tend to fill up hollows and smooth out the hummocks and this brings the land constantly into smoother condition. Many farmers go out at spare time and scrape off hummocks, filling in the depressions. That is constantly continuing process from year to year. In some places they start in systematically and spend considerable money smoothing the land. In Northern Italy they go to an expense of several hundred dollars an acre in preparing land.

The crops the land will yield and the people it will support gives it its value and warrants an expenditure of money in the manner I have stated. This process has been going on constantly in Poudre Valley and land has been increasing in value. The population has been increasing. Building has been increasing and the income from the land as a whole has been on the increase. Of course, all these conditions have made conomic conditions more favorable for improvement.

Poor land producing small returns is liable to mean a low duty of water and waste of water. The crop return is small and is generally true that the water is used with relatively poor economy, at least so far as *though* conditions are concerned. They cannot afford to go to much expense to save water. It is the general consequence that such communities are usually extravagant and wasteful in their use of water.

2322 Changing of character of crop raised and method of irrigation in Poudre Valley has not made so much change in quantity of water used in depth as have other conditions. It has made a great deal better use of supplies of water that are available in valley. Instead of running water to waste unused down stream, a greater quantity is utilized now than formerly. For illustration, in the first stage, wheats and oats were principal crops. They mature in June and likewise alfalfa, when it was started, called for water in June but could use water to benefit later on. That meant the demand of the valley was pretty nearly parallel to flood stream in June, but in July of course there was little water and crops then did not use all of that. By changing to potatoes and sugar beets for part of their lands, there is a demand in July and August for more water than the stream will supply and that requires storage reservoirs for storage of the peak of flood and they use that water in July and August for these crops. It also means another economy for use, that is, a psychological principle, that a person who depends upon natural streams for water applies the maximum quantity

2323 in irrigation because of waste, and thinks that the time to use water, as they say, is when the water is there. This means that their tendency is to apply water when they can get it from the stream whether the land really needs it or not, for fear that later on when they need it, ordinarily, the water is not within reach. Hence they use the water practically on the supposition that the weather is

going to turn dry, and if the weather is, on the contrary, wet, they then have used an unnecessary amount. Under reservoir use, having water available, they are not under that pressure and they can then wait for a greater or less extent until they actually need it. When they use this method they find that a great deal of their prospective irrigation is unnecessary. This is really quite a source of saving and a means of extension of use.

With reservoirs owned by mutual companies the stockholders divide the quantity of water in the reservoir by the number of shares of stock. The stockholder draws on the supply available and draws with the modifications that are necessary in order to make a practical order of distribution. With the modification that one man could not call for his water to be delivered through a long ditch and be the only person demanding or receiving water, the farmer receives his water just as he needs it. They have to make some limitations and restrictions as to the number of farmers who must call for water at the same time in order to make delivery.

With all crops cultivated in rows, such as potatoes, beets, cabbage, onions, truck and garden produce, water can be applied somewhat more economically because the loss by evaporation is lessened.

2324 The net return from the crop produced gives the land its value. The net return on agricultural lands in the Poudre Valley has been very much increased with increase of acreage of rowed crops. This, of course, has been parallel with other causes which it is difficult to distinguish at times. Historically it is a decided fact. It is also historically true that the duty of water has been increased with the increase of crop returns. This process of increase of duty under the old canals with consequent increase of irrigated acreage is still going on. The same conditions forcing the greater use of water exist now as then. The value of water is constantly tending to increase and hence it appears to me that what has taken place *is* past years *in* bound to continue and to increase for future almost indefinitely. Our lands, for instance, are worth $100 to $200 per acre. In southern France, for instance, even unirrigated lands are worth twice that much with less rainfall than we have and irrigated lands are worth a great many times what our lands are worth. Just so long as all these causes tend to increase the economy of water there will be a resultant progressive effect.

The Larimer County Canal of the Water Supply & Storage Company is about the only canal on which I have available data for illustration of ability to produce agricultural crops in Poudre Valley under economical management. For some years I kept a record of Cache la Poudre Canal but I have not those available. I

2325 also kept a record on Larimer County No. 2 and New Mercer Canal. I cannot give those figures exactly. This was 15 years ago. In case of Water Supply & Storage Company's Ditch, Laramie County Canal, we have a record of water uesd there kept systematically by that company for a series of years. That is best instance we have in valley. It is one of few instances where record has been kept, so that it is available. It has been kept with care.

Conditions on that ditch have been such as to exercsie constant

pressure towards economy. It used to be so especially. I have mentioned that people using water are apt not to have that economy unless they are constantly pressed in that direction. In 80's and 90's that ditch was somewhat pressed for water and this forced them to construct reservoir systems and forced them to bring water across the range. Exactly the same conditions forced them to be careful in their distribution of water and in carrying water and therefore constantly pushed towards economy. I think it is absolutely necessary towards getting economical use.

I have here the record of Larimer County Canal since 1895, up to and including 1911. That is inflow at headgate. The amount taken from river. That is measured or taken daily by gauge heights in rating flume. That flume has been rated at different times
2326 so that it is fairly accurate, and transfer of those depths into quantities is therefore pretty reliable. It might be said that this then includes the amount also that went into reservoirs, and while from any individual year totals might be affected by the fact that water is exchanged to some extent from some of their reservoirs, turned down into other ditches, and they might not have been paid back exactly, that is, the amounts might not have exactly balanced at end of year, if it increased one year it would decrease in the next, so that the aggregate for a series of years would do away with that. They might carry over a small balance at the end of the year and might receive a little more but it is practically eliminated in the course of a few years.

The Water Commissioner keeps a book account of all ditches and reservoirs and credits and debits the accounts against each throughout the season. He does of all those that use the stream in any way by their exchange. That is what I refer to in the matter of balances. When they exchange without going through the main ditch, where one trades with another, he at any rate doesn't usually keep track of that. It is out of his jurisdiction. He may do so in last few years, am not positive. They generally have separate man to keep accounts who is independent of commissioner and is paid by ditches. He does keep account of all that goes through river.

I have here amounts in acre feet for each of years under Larimer County Ditch and I may say those acre feet values I have obtained by simply multiplying cubic feet per second for one day by two, which is within less than one per cent of what it would be if we made careful comparison, and that inaccuracy would not be of any great note. In 1895 there were 6,520 acre feet, that included, I
2327 may say, December of that year, which of course went into the next year's storage. We have in 1896, 51,879 acre feet; 1897, 63,115; 1898, 29,843; 1899, 83,035; 1900, 65,110; 1901, 66,763; 1902, 46,191; 1903, 69,356; 1904, 63,665; 1905, 54,650; 1906, 79,955; 1907, 79,210; 1908, 63,664; 1909, 64,028; 1910, 42,986; 1911, 52,232. This means an average for this period of 60,928.

The acreage under that ditch has been throughout this time probably not less than 45,000 acres. I think it was stated in testimony in this case that it is figured about 50,000 acres. At any rate, it has been considerably in excess of 40,000 and would average some-

where between 45,000 and 50,000 acres. If we call it 50,000 acres for ease of division of the amount, that would then be an average of 1.2 acre feet at headgate. If it was 45,000 acres it would be .1 greater, that is, about 1.33 feet as the average depth. This system uses reservoirs and thus has that condition for using water to best advantage and economy. It is long ditch, something like 70 miles long. It has late water in season to considerable extent and it is also a system that has been practically on outside of irrigated region, that is, it is on boundary of irrigated region of Poudre Valley. Between irrigated section and unirrigated plains.

Larimer County has received during this time no benefit from return or seepage water from other canals. There is only one other canal above it and that is confined to upper end for a few miles. That is, north-Poudre System. There has been practically no seepage from that canal unless it has been within the past few years.

1.2 acre feet at headgate includes all water that has entered
2328 the headgate. So far as service to the land under canal is concerned, that figure includes all losses in transmission through the canal, all losses in distribution, all amount that has gone into subsoil and all wastes incident to distribution and transmission. It also includes evaporation from canal and reservoirs. The figures represent gross amount which could be charged to each acre of system at headgate before any of these losses have been deducted.

These figures represent duty of water under canal and measured at headgate under conditions as they existed. I do not have here any record as to losses occurring during carriage and distribution. I will obtain such records and furnish them later. I think they are at experiment station, but possibly I have a copy or index from which I could determine amount.

Larimer County Canal of the Water Supply & Storage Company in situate just beneath the Greeley-Poudre Irrigation District and forms for a great portion of its length the lower boundary of
2329 the district. Lines of district works are contiguous and similar in character to lines and works of Larimer County system. In fact these lands form a strip parallel and along the Larimer County Ditch for a great many miles. The strip is only a few miles wide. There are no essential changes in soil conditions or otherwise. The region is practically the same.

History of Larimer County Canal is in large measure a forecast of Greeley-Poudre System in matters of water service. It is a very good basis for judging what will take place in irrigation of the land. Lands under Larimer County Ditch are much the same as those under Larimer and Weld or under Greeley No. 2 Canals. I think they are fully as good as under the latter canals and certainly not inferior. Possibly taking drainage into account, I think they are as good and in many cases better, that is, some of the lands near river have become water-logged to some extent and lands further from river are less subject to that. That is only temporary damage, however, along that line drainage has been done in several cases by persons having land below who have made drain ditches for sake of getting water, or, in one case, it was done by public spirited Greeley

man who ran drain ditch at his own expense and sold the water. He derived some revenues from it but his idea was to demonstrate that it was a desirable thing to do and would justify expense.
2330 That was Governor B. H. Eaton. The water in that case was sold to other users for more than enough to pay for cost of ditch. He sold it for $5,000. Speaking again of Larimer County Canal will say that there is only a slight difference in drainage of lands under that canal and other canals mentioned. These general changes that took place in the raising of ground water which I have already described, affect the lands near the stream more than those at some distance, as water gets nearer the surface and that means there may be some per cent of the lower lands where water comes too close to the surface and needs to be drained.

The Central Lateral of the Greeley-Poudre Irrigation District's distribution system, testified to by Engineer Wortham and others, constructed for re-capture and re-use of water within the district itself in connection with Camfield and March Reservoirs located below and fed by that lateral, will tend to greater use of water in district undoubtedly. The Central Lateral is about 3 or 4
2331 miles from main ditch and thus there is strip 3 or 4 miles above it. Below that lateral is a strip of land 6 or 7 miles wide close to Larimer County Canal. Use of that lateral will be to capture drainage water above it and also waste water. Will also be available to use as distributing lateral, so I think there is no question it will aid in economy and the use of water, but I would hesitate to say it would increase over Larimer County Canal in so far as that one fact is concerned. It would tend to increase duty of water over what it would be without it. It is a very excellent part of the plan.

Judging from experience of other canals in Poudre Valley, it is safe to say that in course of time there will be more or less seepage ditches constructed in the large body of lands going to make up the Greeley-Poudre Irrigation District. As district develops and subsoil fills up with water, which will be the natural outcome, a large part of the water or most of it will undoubtedly be re-used within the confines of the district. Under Larimer County Ditch seepage and return waters appearing are used almost exclusively on lands
2332 below that irrigated by the canal. They are used under Laramie and Weld and Greeley No. 2 Canals. Laramie County Ditch in fact loses almost altogether the benefits of its own seepage.

Natural presumption of future use of water under Greeley-Poudre System as compared with Larimer County resulting from facts I have just described is that there would be a saving in water by the Greeley-Poudre System and utilization of water that is not utilized similarily under Larimer County Canal. The water thus saved would then be an additional use and a reduction of the average supply required and used, as compared with Laramie County Canal. The tests I have made in Poudre Valley show that about one-third of water that was taken out of ditches reappeared as seepage. This deduction was arrived at at time I published report on seepage and result of subsequent measurements, in course of publication, indicate

rather a larger percentage. I am inclined to opinion that the proportion of water which would return and reappear as seepage water within the large body of lands going to make up the Greeley-Poudre Irrigation District, may be judged by experience on other ditches.

As I mentioned in 1896 I concluded at that time this was about one-third of original water. I see no reason why there should not be as much as that returned from the waters of the Greeley-Poudre System

2333 because the conditions are very much alike. The upper portion of the district is so situate that a great deal of the water from that will reappear below the district, but on larger body of land will probably appear within borders of district. That is not a matter of conjecture entirely, because we know the conditions that are existing as a whole and we know the tendencies, so that I think the matter is only partly conjecture; that is, the extent of return and time could not be stated exactly, but we know pretty nearly from the similarity of other conditions. In answering your question a few moments ago about the Central Lateral I did not take into account the seepage. My latter answer was more nearly correct.

Crop production under the Larimer County Ditch compares very well with crop production under Larimer and Weld and Greeley No. 2 Canals. I could not give specific statements but in going over country under those ditches they show up approximately as well. The other two ditches mentioned are somewhat older in their development. The houses and farms are somewhat better developed and the farm owners have gotten a little further along financially, this shows to some extent. Under the Larimer County Canal they are as well if not better off than farmers under Larimer and Weld Canal were at same period of development. Latter Canal is a

2334 number of years ahead of the Larimer County Canal. There has been great increase under these three canals since I have known them by extension of canals and covering of additional acreage as I have previously mentioned. This has been accomplished by building laterals, by separate co-ordinate companies not part of the company managing main canal, but consisting of corporations of users who have combined together for distribution. Some of these laterals run 10 or 12 miles. Referring to the map, Exhibit 1, attached to the answer of corporate defendants, there appears the Pierce Lateral which is a lateral from the Larimer County Canal That does not extend much further east than the original ditch but is built parallel to the original canal and at a lower grade. It starts up ditch some miles and covers considerable territory eastward and parallel to Collins lateral. Collins Lateral begins at crossing of Union Pacific Railroad, between Greeley and Cheyenne, main ditch terminating at that point. On map it appears without designation as a continuation of Laramie County Canal. Physically it is continuation. The Larimer and Weld Canal was carried as corporate enterprise few miles east of railroad. That has been continued by lateral known as Owl Creek Lateral. It is 12 or 15 miles long and covers lands beyond Owl Creek. This has been brought under cultivation and when I was first over there, 20 years ago, that was undeveloped. This lateral appears on map as continuation of

Larimer and Weld Canal without distinction as to continuation, and forms part of boundary of Greeley-Poudre Irrigation District
Greeley No. 2 Canal, or Union Colony No. 2 Canal as it
2335 appears on Exhibit 1, has likewise been extended beyond original point of termination. This canal extends beyond two miles east of Union Pacific Railroad near Lucerne. Map shows continuation beyond that by two laterals which are not distinct from main canal. One runs to Crow Creek, a distance of about 15 miles. These have been built within last few years. They are not part of original construction and have been possible simply by the fact that same amount of water was capable of serving larger tracts as time went on. There is nothing to prevent reclamation of still larger tract- of lands under this canal. Just as far as the economies which have been mentioned prevail and as fast as land is filled up so that existing land does not take so much water and under the pressure of conditions such as have prevailed in past and prevail today, this extension undoubtedly will prevail. The same is true of the other canals I have mentioned. We find such conditions in history of Indian Canals. For instance, in construction of some of large canals that were built, in one case, the Chenab Canal was designed to cover 1,100,000 acres, and the engineers had recommended 1,200,000 acres. The administration thought they had better confine it to 1,100,000 acres. They thought that was all the land
the water would supply and it was only a few years after
2336 that same canal was extended after the filling in of the subsoil. They found that they could irrigate about 2,500,000 acres instead of 1,200,000 acres. They applied that idea in the planning of construction of more recent canals, wherein Colonel Jacob, Chief Engineer of these provinces, recommended that while they did not at the present time expect to supply more than 2,-000,000 or 2,500,000 acres, it would be planned to cover 5,000,000 acres, expecting it would not be many years before they could irrigate that much. These canals illustrate the same consequence and conditions that prevail in Poudre Valley.

There is no obstacle to prevent serving of large additional acreage east of Greeley-Poudre District in after years the same as under other canals. So far as canal is concerned there is very large body of land lying east of Crow Creek that can be supplied and would be equally as good if brought under irrigation. Consequently conditions there are favorable for extension and utilization for any water that may be spared with growth and economy in future.

Testimony as to crop productions generally, values of lands already irrigated, etc., in Poudre Valley might be some index of possible development of land east of Greeley-Poudre District at some future time. It takes it almost out of the realm of prophecy so far as this case is concerned and puts it on a basis of reality. Judging from history of other irrigation systems, irrigation of this increased area will occur without increased demand upon the water supply
from either the Laramie or Poudre Rivers. Experience of
2337 other canals indicate- that the area served can constantly increase after a few years. This will occur with same amount

of water. This subsoil at first takes up a great deal of water and after a few years there is no longer necessity for so much. These and other matters tend to increase effectiveness of water and therefore increases duty and increases acreage with decrease of amount of water used. There is no physical obstacle to increasing the acreage of the Greeley-Poudre District as future experience may prove provident. There is no legal obstacle to the natural extension and growth of the area after they get their supply of water and obstacles of that kind have been overcome and have disappeared.

Wyoming water rights are limited to a certain acreage. This probable increase of irrigated acreage would not be as rapid under the Wyoming system as under the Colorado system. There is no inducement under the conditions for a man to exercise economy and that has a great deal to do with the ultimate economy. While the doctrine making water pertinent to the land was quite popular among engineers a few years ago and looked pretty good, I will say myself, yet in seeing the effect on development in later years I am very doubtful of its wisdom, because it appears to me to serve as a brake on development of community in this respect.

2338 I have also had occasion to make measurements or collect data in several cases on Arkansas and South Platte Rivers. I had self-registering instruments on individual areas and have very often attempted to get data of canals where they were keeping records. These records were generally disappointing and some of records I kept of measurements are not available at the present time. I have here results of Fort Lyon Canal, a very long canal, in Arkansas Valley. I have 4 years' record of that canal. One is 1899 and the others are the last 3 years. They show in 1899 the total depth in irrigated area was 4.4 feet over an area of 40,000 acres, which was pretty close to the amount then irrigated. In 1911 depth over area was 2.95 feet; in 1912, 2.86; and in present year, 1913, 1.7 feet. These last three results are taken from official reports based on daily intake readings. They show quite a decrease in amount of water used which I think is a real decrease. Country has been filling up. We have that effect as well as the other effect of which I have spoken, that the lands have become more valuable and they are farming more carefully. Crops are worth more and so there is presence of these things which give economy. That is a mutual canal. It is a large one both in size and length. It is about 116 miles long. I think this record is indicative of the changes that are taking place.

2339 Amity Canal in 1899 I have a record of and also for several years previous but I do not have the recent years. Amity Canal is also in Arkansas Valley. Quantity used in those years is very much like that of Fort Lyon Canal. Headgate of canal proper is near Old Fort Lyon, just above Lamar. They used in 1897 4.8 feet; in 1898 they used 6 feet and also in 1899. Now they were then filling up the country. Many of the tracts that were then being irrigated were not contiguous. They were isolated. Hence conditions were such that the amounts would be excessive. From what

I know of situation, I know amount now required is less, but I do not have figures.

If amount of water heretofore used in Poudre Valley for filling up subsoil remained in subsoil instead of gradually running away, so that it finally came up to surface, it would tend to lessen room for more water and lessen amount that would need to be supplied. It would finally tend to destroy some of the land.

Reservoirs have been constructed for supplemental supply to Greeley No. 2 canal and other canals. The increase from this source is not so great as the increase of acreage brought about by greater and more economical use of water.

2341 HIRAM TIMOTHY, a witness for defendants.

Direct examination by Mr. Charles F. Tew:

Have resided at Greeley for 12 years past. Am agricultural superintendent for The Great Western Sugar Factory at present. Was agricultural superintendent at Sugar Factory at Windsor and Eaton and also at Fort Collins. The company I mentioned is corporate owner of all beet sugar factories in Cache la Poudre Valley. Prior to coming to Greeley was engaged in sugar beet business in Rocky Ford, Colorado, for 2 years, in service of The American Beet Sugar Company in Arkansas Valley. Prior to business in Arkansas Valley was in sugar business at Lehi, Utah, about 9 or 10 years prior to that.

2342 23 years ago last November, I started with beet sugar companies. During last 2 or 3 years that has been my principal business. I am in charge of field work.

My business is to hire field men. We have crew of field men for each factory. I have 4 at Greeley, 5 at Eaton, 4 at Windsor and I think 6 at Fort Collins now. My business is to look after these men, shape up business for them and help them instruct farmers how to prepare land and raise sugar beets. During time I was engaged in sugar beet business outside of Colorado was engaged in same branch of work. While engaged in this work we pass over the area devoted to beet culture every week. For illustration, it takes 830 miles riding just for the Greeley factory alone to see every field of beets. I have 4 men riding that route continuously and I aim to take a trip over it once a month with the field men. We travel by automobile entirely.

Also have superintendence of harvesting, gathering, weighing and transporting beets to factory. Have charge of delivery of raw material.

2343 Superintendents held responsible in every mill for raw material. I keep in touch with different dumps and receiving stations. I hire all the men. I also have superintendence of the department which has charge of disposal and utilization of by-products. Pulp and molasses are fed to cattle. Some of it is carried away. Scope is getting wider every year, with both molasses and pulp. We have men hauling pulp now 12 miles from our factory. In former years they would only haul it 2 or 3 miles.

Pulp is solid matter of the beet. It is a valuable stock food for

cattle and sheep. Many thousand cattle and sheep are fed each winter at these factories.

The molasses used for feeding is a refuse from juice of beets. It is that part which will not granulate. It has about 52 to 54 per cent purity but it is a class of molasses that will not granulate. We use this molasses for cattle feeding. Feed it directly on the pulp. Some cut their hay and spray it on the hay as the hay is
2344 cut. We feed most of molasses on pulp at time of feeding.

I am continually observing crop returns under different methods of agriculture. That has been my duty and practice through 23 years I have been engaged in sugar business. The factories in northern Colorado controlled and operated by Great Western Sugar Company are high class factories. They are more efficient than any factories I know. They keep them up better and spend more money on them annually. They carry on constant experiments to determine cost of production and ways and means of economy in culture of beets, in harvesting, in saving of sugar and in methods employed. At Greeley factory we have not been trying to experiment, but have an experiment station at Longmont and one at Sterling, where a great many thousands of dollars are expended annually in experiments. All of us go down and visit these places once or twice a year. The object of these experiments is to save cost to farmer, so that he can produce beets cheaper and avoid thinning them. We tried 200 acres this year. We plant beets and
2345 go across them with cultivator, simply taking pulverizing harrow and not thinning them at all. We tried this and after harvest ran them through factory to ascertain cost and value of crop. If thinning were eliminated it would save $6 per acre. That would be quite an object on 150,000 acres of land. We make experiments to assist farmer to obtain highest results both in crops and returns. We have men hired for that purpose to visit every field. I think I can advise a man how and on what land to raise beets to make a success of the business. From my experience I am able to make a comparison of the worth of lands for raising sugar beets. Am acquainted with season required and character of climatic conditions necessary for successful beet culture. Have also taken statistics from other factories. Have tried experiments in high countries and low countries, hot countries and cold countries.

2346 Fort Collins, Windsor, Eaton and Greeley factories are all situate within irrigated territory known as Cache la Poudre Valley. Major portion of beets for Greeley factory comes from Platte valley.

I can give you exact tonnage for years 1912 and 1913 received at different factories. Can also give number of acres of sugar beets tributary and delivering their product to the four factories in Poudre Valley. They are as follows:

1912, Fort Collins, 12,348 acres;
Eaton, 10,480 acres;
Greeley, 10,088 acres;
Windsor, 10,348 acres.

This makes total of 43,242 acres supplying beets to these four factories for 1912.

For 1913 acreage was as follows:

Fort Collins, 14,392 acres;

Eaton, 16,597 acres;

Greeley, 11,489 acres.

Windsor, 13,401 acres, making total of 55,879 acres.

Average sugar content in those beets in 1912 obtained from different areas described tributary to several factories *are* as follows:

Fort Collins, 16.61 per cent saccharine matter;

Eaton, 16.84 per cent;

Greeley, 17.009 per cent;

Windsor, 16.30 per cent saccharine matter.

Average saccharine content for 1912 for four factories was 16.71 per cent.

Sugar content in beets received in four factories for 1913 was as follows:

Fort Collins, 15.38 per cent;

Eaton, 15.72 per cent;

Greeley, 15.27 per sent.

Windsor, 15.53; thus making average for all four factories of 15.47 per cent.

Average price per ton paid in these years from the different factories was as follows for 1912:

Fort Collins, $5.92 per ton;

Eaton, $6.05 per ton;

Greeley, $6.10 per ton;

Windsor, $5.87 per ton.

For 1913 Fort Collins paid $5.53 per ton;

Eaton paid $5.56 per ton;

Greeley paid $5.51 per ton;

Windsor paid $5.51 per ton.

The average price for 1912 for four factories was $5.98; for 1913 was $5.53 per ton. In 1912 our silo beets were included in the figures of $5.98 per ton, and in 1913 that has not as yet been figured, but we have the figures $5.53 without the silo. The contract with each farmer provides that they shall silo 25 per cent of the gross tonnage. In 1912 it brought that up a little higher. This
2348 year it is not yet figured in average price. The variation in price described between 1912 and 1913 is in part due to fact that silo portion of crop is not included in estimate for 1913. We agree to pay $.75 per ton in addition for siloing sugar beets. We find that in Northern Colorado it is necessary, owing to our heavy tonnage, to have farmers take care of 25 per cent of crop because we only have about 65 to 75 harvests days' time and if we pile them all up at the stations they will heat and spoil. We contract with farmer to silo 25 per cent of beets so there will be that per cent retained on farm until we need them. We pay 75 cents per ton extra for that work.

We expect to start our factories by October 1 each year. Length of season in grinding beets depends upon quantity of crop. It gen-

erally terminates about January 1. During that time the
2349 factories operate day and night. They never stop until we are through. Do not know how many men we employ at Fort Collins. Greeley factory has 338 men on payroll to operate the mill. This includes dump men. Greeley factory has 10 dumps. Windsor has about 15 dumps. Other factories I have mentioned employ more labor than Greeley factory.

Average yield of beets per acre in 1912 for Fort Collins factory was 12.08 tons; for Eaton was 15.40; for Greeley was 12.07; and for Windsor was 13.45 tons. The average for 1912 was 13.25 tons; in 1913 average yield was as follows: Fort Collins was 11 tons; Eaton 13 tons; Greeley 12 tons; and Windsor 12.98 tons. The average for 1913 was about 12.78 tons per acre.

The total number of tons of beets harvested for these factories for 1912 and 1913 is as follows:

1912 Fort Collins 149,232 tons;

Eaton 160,965 tons;

Greeley 121,727 tons;

Windsor 138,931 tons. Total 570,865 tons, that is the four factories in 1912.

In 1913 the four factories harvested as follows:

Fort Collins, 158,165;

Eaton, 217,899 tons;

Greeley, 137,484 tons;

Windsor, 173,911 tons; making total of 687,459 tons.

The average yield per acre for the years 1912 and 1913 includes all acres both good and bad. On high class land the tonnage runs quite a bit higher than that I have mentioned. Am familiar with the quantities and location of the land which gives higher crop returns. The Greeley average of 1912, 12.07 tons per acre, includes the Platte Valley area as well as the area tributary to the Greeley factory in the Poudre Valley.

The Pleasant Valley territory north of Greeley is the most productive land farmed in connection with any
2351 of the factories I have in my charge. That is in the territory of the Eaton factory. As field superintendent I have become acquainted with the lands in general which are within the confines of the Greeley-Poudre Irrigation District. I have been over them. The soil in the lands of this district is a lighter than the Pleasant Valley soil. In my opinion, the soil in the district would be more productive. I believe there is a little more sand in
2325 it. It is a sandy, clay loam, while the other down here is more of a clay loam. The Greeley-Poudre District lies adjacent to the territory of the Eaton factory. Generally speaking the two are similar. The difference in elevation would not be observable.

The Cache la Poudre Valley is superior to the Arkansas Valley for the culture of sugar beets. It produces 2 to 3 tons more per acre. The San Luis Valley only produces 6 or 7 tons per acre. This is at a higher elevation than the Poudre Valley. I attribute the short return to the high altitude. The season is too short. The

Cache la Poudre Valley is superior to any of the land along the Platte Valley.

2353 Made investigation of land on Laramie Plains to determine adaptability of such lands for successful culture of sugar beets in company with other officers of the Great Western Sugar Company. Parties there wished to raise sugar beets and we made an investigation of the territory. I cannot remember the names of the parties, but we were invited up there by a little farmers' club, at Bosler, Wyoming. We were invited to stop at Laramie. Bosler is station on Union Pacific on Laramie Plains. I went to Laramie on train and took automobile from Laramie to Bosler in company with Mr. S. M. Edgell of Greeley factory, and Mr. C. H. Turner, superintendent at the Eaton factory. I

2354 cannot find any records of the date. It was about February 1, 1911. Went to Bosler, Wyoming, by invitation of farmers. They wanted us to give them district to raise beets and furnish them man to help raise them as we had in other districts. We went up and held meeting and next day went out to inspect land, with understanding if we thought land and climate suitable, would send seed up to those farmers and send man up there to help them prepare land and sow beets. In going over territory next day we found that land in my judgment was of nature that we could not recommend it to our company. It was also far away from the factory and we did not ship any seed up there. It is an adobe clay land on the low lands and has heavy gravelly clay on the upper lands. It was unbroken and uncultivated at that time, the greater portion of it. We did not think the land was fit for sugar beets, besides we found that the season was too short to mature sugar beets. The altitude of 7,000 feet would not have made any difference if the season had not been too short. The season however, was too short, whether due to altitude or other conditions.

Stopped at Laramie on account of invitation to stop there

2355 and see real estate men and also in order to arrange hotel accommodations. In journey from Laramie to Bosler noticed character of territory. Noticed land. That was our business up there. The Laramie Plains are not fitted for successful culture of sugar beets. I would not plant them. It would be pretty hard to compare the Laramie Plains with the Cache la Poudre Valley. There was very little humus in the soil. The germination of the seed would be almost impossible. We did not wish to open up a territory and induce farmers to raise beets when, in our opinion, the proposition would prove a failure. I reached this conclusion on more than 20 years experience in raising beets in several states.

2356 The number of cattle and sheep on feed at present time consuming by-products at Eaton and Greeley sugar factories are: At Eaton there are feeding today 4,394 head of cattle and 63,850 head of sheep; at Greeley, 5,504 head of cattle and 35,456 head of sheep. There are more than twice as many sheep and cattle on feed at Fort Collins than at Greeley. They are feeding about as many sheep and cattle at Windsor factory as at Greeley factory.

All of these sheep and cattle are fattened for market. As soon as they leave the factory they will go in for slaughter. Num-
2357 bers that I have given are those of the stock that first came in. They are refilling their corrals to finish the season. Those feeders who come in early are able to feed more than one consignment during the winter. These cattle and sheep are fed in corrals and feeding pens established near the factory. In addition to that a number of other cattle and sheep are fed at places remote from the factory.

Sugar factory by-products are very valuable for stock feeding. Considering the price, they are superior to corn. For this reason, they are largely fed. They do not feed corn so long as they
2358 can get pulp and molasses.

Tonnage of beets was less in 1912 than in 1913. This was on account of the shortage of water and a very hot August. August is month when beets grow the best. Lack of sunshine in ripening season of beets effects sugar content. We do not have sufficient lack of sunshine in Colorado to affect the crop.

I will describe process of production of sugar beets from planting to reduction for sugar. I have assistants called field men.
2359 We go out and contract beets. We contract our acreage in February. We purchase and furnish the farmers the seed to plant. We ship that to them in March. We obtain the seed from Germany. The seed costs the farmers 10 cents a pound. We wait on them for our pay until the harvest of the crop. At the time of plowing land, we send men out to show them how to plow and to select best land on farm. Every year we have new farmers. Field men show farmers how to level and roll land. We furnish drills for every man who does not have one or who does not have opportunity to get one from his neighbor. We instruct how to plant. Planting generally begins about April 10. At that time our field men have to be on duty day and night. They use automobiles. We expect beets to come up in 10 to 15 days after planting. We then cultivate beets as soon as possible, preparatory to thinning. It takes both heat and moisture to germinate the seed. If the climate is cold and windy the seed will lie in the ground. If it lies too long it will rot. If it is continuously cold the seed will fail to germinate. Continuous wind would dry the ground and blow the soil away. When the beet sprouts it is a very tender plant.
2360 The wind would probably kill such plants. It would cut them off.

Our next step is to find the hand labor for thinning the beets for the farmer. The farmer pays $20 per acre for all hand labor on the crop. The hand labor consists of blocking and thinning, second and third hoeing, and in the fall the pulling, piling and topping of the beets.

Beets are planted in one continuous row. 20 pounds of seed are planted per acre and as result we have seed to every inch in each row, and every pod has anywhere from one to six germs and they come up thick in the row and have to be thinned and hoed
2361 so that there is one plant from every 7 to 10 inches. The plants are thinned out so that the beets will grow to large

size. Beets are first blocked with a hoe and left in little bunches and then thinned by hand. One beet is left in each place. We leave them 7 inches apart in the row on good land and 10 or 12 inches on poor land. By good land I mean such land as lies north of the Poudre River. It requires about six weeks to finish the blocking and thinning. The beets are not irrigated during this time except in rare instances where the subsoil has dried out.

2362 After thinning, cultivation comes next. Irrigation begins about first week in June. The beets are hoed and the weeds kept out. There are three hoeings. Contract provides that all weeds that grow must be hoed out or taken out by hand. Weeds are kept out to harvest time. Cultivation of beets is with machine cultivator, generally taking four rows. There are about four cultivations during season. After cultivation the beets are furrowed out and

2363 irrigated, then recultivated and re-furrowed again. Beets are irrigated about four times during the season. This varies some with the land.

Beets are laid by, as a rule, by August 1st. Then growing season starts. Sometimes they are laid by July 15th. In forepart of September we take samples diagonally across field to ascertain whether beets are ripe and whether or not they will go 15 per cent sugar. We hardly ever order beets to the factory that do not go 13 per cent sugar. If we need beets badly we order in 13 per cent beets. We send out written instructions to farmers to harvest their beets when we find them testing up to a certain per cent. These orders simply give the farmer the right under his contract to proceed to harvest. He is not bound to do so. It is optional with him

2364 and he may wait if he desires. This depends upon his convenience.

When I used the term "laid by," I referred to the time when work was completed on the crop. The foliage has grown to such an extent that it would be a detriment to put a team into the field because it would break off the foliage. The foliage will fill the rows. These rows are about 18 to 20 inches apart. Water passes down between the rows in irrigation. Beets are not flooded during irrigation. Flooding of beets is injurious. Dirt must be kept away from crown. After leaves once reach the sunlight covering them up rots them. Flooding would tend to seal the crowns over.

Majority of work of pulling and topping beets is done with two-horse plow, what they call a digger. They have different kinds of such plows or elevators. The plow leaves the beets standing

2365 in the row all loosened. The hand labor piles the beets up in piles from 12 to 18 feet apart. They throw them on a place cleaned for that purpose. The hand labor then removes the tops with a large knife. These knives are made for this purpose. They pick up a beat and chop off the top, throw the beets in the pile there and tops in a pile here. Topping has to be done in a certain way, cutting off top below base of bottom leaf. Beets must be taken by hand and topped with a knife. Most of this labor is done by contract. It is a part of the labor included in the $20 per

acre contract. Hand labor begins with thinning and ends
2366 with topping of beets. It includes the labor included in pulling out the beets and piling them. This hand labor averages $2.62 per day for time actually employed in their work. These figures include men and women and children 12 years old and over. These children do the thinning after the hoeing. A great many make $4 or $5 per day.

After the topping and throwing into the piles the beets are then loaded onto large wagons provided with large beds made for the purpose and are hauled to the dumping stations. At each
2367 dump station there is a weighman or weigh officer for the factory. We have several employes there to receive beets, to weigh them, tare them, and then dump them. A man to move cars and a dirt man to wheel away the dirt that falls from the dumping.

Tare is obtained by putting beets into baskets and weighing them. They are then cleaned and weighed back and what is lost in weight is the tare.

The wagons are built about 15 feet long, 6½ feet wide. They come out over the wheels but have a flat bottom and for that reason the beets fall out as we dump the wagon with the dump. This character of beet bed is manufactureed in Greeley. It is especially prepared for the purpose.

Our dumps are constructed 18½ feet high and the approach is 220 feet long. Some approaches are 250 feet long by reason of going up a little grade There is a landing on top of the dump of 40 feet. It is a flat surface with a dump there. We have two kinds of dumps; one works with a lever entirely by weights, while the other dumps automatically. You drive on and there is nothing to push it over or push it back. It has a rocker rollway. It rocks over and dumps the load, and when it has dumped it tips right back. The wagon goes with it. The labor of hauling
2368 and dumping the beets as well as of loading the wagons is done by the farmers. It is invariably the case that we do not have enough cars to carry away the beets from the dumps.

At the various beet dumps we had piles of beets of about the following tonnage during this last fall:

Eaton factory, 55,000 tons at dumps;
Greeley, 37,000 tons;
Windsor, 40,000 tons;
Fort Collins, 60,000 tons.

These piles are about 9 feet high and they cover from 400 to 500 feet in length and from 150 to 200 feet wide. We had one
2369 pile 9½ feet high and covering a city block. We had 5,000 tons there. This piling is in excess of that portion siloed by the farmers. Siloing beets means that a man will take 25 per cent of his crop and pile it in piles in his fields or along some road close to his field and cover the pile with dirt to protect it from frost and sun and will deliver them as we call for them not later than January 31. After October 10th, the farmer may dig the beets as fast as he chooses. Prior to that time we expect to grind the

beets as fast as harvested. After October 15th the farmers harvest their beets faster than we can take them.

2370 Beet tops are a valuable feed for stock. They commonly sell for $2.50 to $6 per acre. They are fed to cattle, sheep and horses. They are used for fattening purposes. I have known sheep and cattle to be fattened upon beet tops alone.

After beets reach factory they are stored in large bins before being sliced and reduced to sugar. At Greeley the wagon sheds

2371 have a capacity of 9,000 tons. We have three railroad tracks, high lines, with capacity of about 12,000 tons. They are about 440 feet long.

In bottom of each bin we have what we call a flume or sluiceway covered over with boards. Beets are loose and lying on top of flume. Two men take boards up with steel hooks and the beets roll down into flume. Water is running in flume and beets float into factory. Flumes are made of cement. They are 22 inches wide by 32 inches deep. From the time the factory starts these flumes are kept in continuous operation in carrying beets. Just one flume delivers beets to the mill at a time.

In the mill the beets go into the washers first, and then into the cutters. This department of work is one with which I have not been directly connected.

My specialty for 23 years has been growing of beets and supervision of harvest. My attention has been devoted to that branch of the industry, concerning planting, tillage, irrigation, harvest and delivery of beets to mill. This includes selection of soil and judging of character of soil fitted for beet culture. The conclusions I

2372 have given are based upon experience in practical operation of beet culture. I do not pretend to give technical knowledge.

Cross-examination by Mr. N. E. Corthell:

2372 The one visit I made to the Laramie Plains in connection with agricultural questions was the visit to Bosler in February, 1911. I was there for a part of two days and took soil samples at different points in that neighborhood. The price paid by the Sugar Company for beets in 1913 was the same as paid in 1912. The contracts made for 1914 are upon a lower basis, the farmer receiving 30 cents a ton less, the laborers 17 cents a ton less, and the Company losing 40 cents per ton, that is, about 87 cents net difference per ton, compared with 1913. I can give no definite answer to the

2373 question as to whether it is generally conceded by the sugar companies that the industry will cease to exist in about three years.

2374 L. G. CARPENTER, recalled.

Direct examination, continued.

By Mr. Delph E. Carpenter:

I have with me results of some tests of duty of water in Cache la Poudre River in last decade or in early 90's. I have some of

records that I then took in Poudre Valley in case of Greeley No. 2 Canal for three successive seasons.

Depths of water used measured at the headgate were as follows: In 1890, 1.86 in depth; in 1891, 1.59 in depth; and in 1892, 2.09 feet in depth. Greeley No. 2 Canal is the one that is least likely to be economical in use of water. These figures are for water taken in at headgate. I had self-recording instruments and checked with depth and tested it every week during season.

Have record of Larimer and Weld Canal for 1892. This canal lies between Greeley No. 2 Canal and Lorimer County Canal. In case of Larimer and Weld Canal for that whole season, depth of water used was 1.49 feet measured at headgate.

For many years I kept records at Cache la Poudre Cañon. Depth use for whole valley for year 1892 was 1.25 feet from May to September. If we include all of September it made 1.30 feet in depth over whole valley. This does not allow for the water that went out of the valley at the mouth of the Poudre, so if that were taken into account it would be reduced somewhat. We don't have records at that point of the amount. In some years discharge from mouth of Poudre was considerable and in every year there was some discharge and in times of floods the discharge would be considerable. I could not answer as to any specific year. It is almost universal for the Poudre River to discharge water from its mouth from June floods. It is common for large amount to be discharged at times, and even in low water there is considerable water flowing from seepage. In the last figures that I gave, am not taking into account the water that went out of the mouth of the stream. I am taking the river as it came out of the cañon and not deducting the amount that escapes from the river. There is a constant discharge from the mouth of the Poudre River the year around. These measurements were made in the 90's. Since that time there has been a tendency to constant gain in the duty of water in the Poudre Valley because of greater economy, filling the subsoil, and greater skill in the use of water. The same quantity of water serves more acres in subsequent years than it did prior to the 90's.

Cross-examination by Mr. N. E. Corthell:

2376 The existing ditches and reservoirs in the Laramie Valley might perform the same functions in an exchange system as the ditches and reservoirs in the Poudre Valley, this being more a matter of personal enterprise and cooperation than of physical situation. All of the principal ditches from the Poudre River were commenced before 1880 excepting the Larimer County Ditch which was started about that time, and the North Poudre Ditch and the Poudre Valley Ditch, started still later. These last two ditches represent from about 12 to 15 per cent of the capacity of the Poudre Valley ditches. Some of the other ditches, constructed prior to 1880 have been increased in capacity since that time. I presume
2377 that the ditches constructed since 1880, together with the enlargements of other ditches, have added 25 per cent to the

carrying capacity of all the ditches in the Poudre Valley, but I am unable to give any definite figures as to the extent of increase. In addition to these new structures and enlargements there are several new diversions going to the various reservoirs.

2378 The larger part of the extension of the area brought under irrigation since 1880 is due very largely, but not entirely, to the extension of previous ditches or building of laterals therefrom. That does not include the area under the North Poudre canal, which is all new since that time, and some under both the Larimer County and the Larimer and Weld canals.

Since 1880 the area has increased from about 35,000 acres to 270,000 acres, an increase of about 800 per cent. The 1880 data I took from statement of Captain Boyd, which I presume to be

2379 correct. The first part of the decade of which I have spoken, from 1880 to 1890, was largely new land under new canals, including that under the Larimer County and the Pleasant Valley & Lake Canals. Am more familiar with the extension after 1888 than from 1880 to 1888. From 1880 to 1890 there was an expansion of about 135,000 acres. The increase due to expansion of existing systems has come largely since 1890.

In 1890 there were existing ditches in Colorado which had made contracts for duty of one cubic foot per second to 55 acres. The Wyoming statute limiting one cubic foot to 70 acres of land was adopted a little later. I heard some of the discussions leading

2380 to its adoption. I came to Colorado to succeed Professor Mead, who went to Wyoming, and this was one of the early questions I heard discussed, and they are speaking of fixing the duty of the newer ditches at one cubic foot per second to every 80 or 100 acres. The standard of one cubic foot per second to every 55 acres was used in a group of ditches constructed by the English company, i. e. the Highline and the Larimer & Weld, which started ten years before. That was not the starting of new contracts. It was not the prevailing standard for existing ditches in 1890, as most of the ditches were mutual and there was no quantity specified in any of those cases. In cases of ditches which were then being, or had then been built in the Arkansas Valley, the unit was one cubic foot to 80 acres, representing more economic use than one cubic foot to 55 acres. Those having the latter unit were not in the majority.

In 1890 three canals in the Laramie-Poudre Valley were selling water rights, and I could not say what their standard was. About that time, two of them became mutual ditches.

2381 The figures I have given relative to the weight of water required to produce a pound of air-dried matter in agricultural crops is not the result of actual practice, but of experiments made with a very small area, such as a pot or a tub, and all waste is eliminated.

2382 My figures showing amount of water diverted and applied by Water Supply & Storage Company in years 1895 and to 1911 or '12, cover just amount taken into canal at its headgate and not amount of water available in stream each year. I think they took practically their full need at times in most every

year, but, of course, like other ditches in that valley, they cut down as the demand decreased. They do not attempt to run constant quantity, and I don't know whether, in some years, there was shortage of water which prevented the canal from taking its full quota. I presume they would have taken more than they actually did, because that is the custom of every man who takes water. I would not say that in each year they took all they were entitled to, but I have no doubt that at times they wanted more water. I noticed in 1897 they drew as much as 468 cubic feet per second at one time, but they dropped down very rapidly after that, which was likely due to shortage in stream, but, at the same time, they evidently supplemented their direct supply from the river with water stored in their reservoirs. My figures have been taken from record kept by the company, with which I have had nothing to do.

2383 The return flow measurements taken under my direction in the Poudre Valley covered each year from 1889 to 1895, and measurements were also made one or two years prior to that time by other persons. My conclusion was that about one-third of the water used in irrigation returned to the stream, and the return flow has increased since that time possibly to two-fifths of the amount diverted.

2384 It is frequently the case that the amount of water taken by a ditch is limited by the supply and not by the necessity of the land, and the duty of water cannot therefore be ascertained solely from data as to the amounts used, it being necessary to consider whether the crops secured have been good or poor. I have known of cases where reports have been made of the irrigation of a very large acreage with a very small supply of water, but the crops were not successful so that such cases are not a proper basis for determining the duty of water.

2385 Relative to the year 1892, it would appear that the stream flow in the Poudre was below normal, being about 70 per cent of the flow of 1891, but I do not have figures with me to determine what the normal flow of the stream is nor what percentage of the normal flow occurred in 1892. My determination of the amount of water in the river that year was taken from measurements made at the head of the valley, and did not take into consideration the return flow along the course of the river.

Cross-examination by Mr. John D. Clark:

2386 Where there are leaky dams and inadequate diversion works, it would indicate that the pressure for water has not become so great as to require the diversion of all of the water available at the particular headgate. There may, of course, be some such diversion works and there are some such along the upper Poudre, but such ditches have to permit some water to pass by to supply prior appropriators. Where the earlier and larger priorities are at the lower end of the river so that the upper ditches must

necessarily permit a large amount of water to flow past their
2387 headgates, the condition of the diversion works in the upper ditches is not so much indicative of the pressure of water upon the stream. This might be true upon the Laramie River in Wyoming if the priority of the Wheatland project is among the early ones on the stream.

(End of Transcript Vol. 5—Defendants.)

2388 E. B. HOUSE, a witness in behalf of defendants.

Direct examination by Mr. Fred Farrar:

Have lived at Fort Collins since 1896. Professor of civil and irrigation engineering at the State Agricultural College. Was born at Evans, Colo. Evans is 4 miles south of Greeley, Colorado. It is 4 miles from mouth of Poudre River. It is located near Platte River. Am 42 years of age. Received public school training at Greeley, Colo. Moved there when *was* I was 6 years old. Received college education, one year at Western University of Pennsylvania and remaining three years at University of Michigan at Ann Arbor. Took engineering course leading to bachelor of science degree, and electrical engineering, taking my electives along line of civil enginering so I had only a few credits necessary for degree of civil engineer. Prior to moving to Fort Collins my home was at Greeley.

I have been acquainted with Poudre Valley throughout my
2389 lifetime. Became connected with agricultural college in 1896 as assistant professor in mathematics. After a few months was made professor of mathematics and held that position for 9 years. Was made assistant professor of engineering under Prof. L. G. Carpenter. Held that position 5 years and then was made professor of civil and irrigation engineering. This is my fourth year in that capacity. I succeeded Prof. Carpenter in that position.

My work as professor of civil and irrigation engineering takes me to experimental work. I have charge of experimental work connected with department of civil and irrigation engineering. Colorado Experiment Station is associated with the Agricultural College. That station is maintained by state with aid of government appropriations through Hatch and Adams Acts and also cooperates with government in certain other lines of work. Have been conducting experimental work along a number of lines. Investigations into problem of measuring water, concerning drainage of land, concerning growth of crops with varying water tables, and concerning amount of water consumed by growing plants of different kinds and varieties. These experiments and observations are not limited to immediate vicinity of college. Some of them are located in different portions of state. The work is state wide in its scope. We constructed special laboratory for purpose of determination of flow and measurement of water. Work has been proceeding there for last year. College constructed laboratory which has been

run in connection with Government cooperation. College and Government each pay one-half of expense. Laboratory is under my supervision. Laboratory was constructed for purpose primarily of making investigations of flow of water over weirs as they are constructed, although laboratory is rather elastic and can be used for other purposes. It is designed, among other things, to permit working out of more accurate or new formulas for measurement of water over weirs.

2391 My work takes me into other portions of the state as consulting engineer or in advisory capacity frequently. Have had observation of irrigation matters throughout the state.

In case of State of Kansas vs. State of Colorado in United States Supreme Court, was assistant under Prof. Carpenter who was then State Engineer.

Have had practical experience in irrigation. Worked on farms belonging to my father near Greeley as a boy. Grew up surrounded by practical irrigation and did a good deal of it myself. Have been in position to observe development of Poudre Valley District for last 35 years.

Have made study from governments reports of size of crops, crop return, population, temperatures and other matters that might pertain to agriculture in counties of Larimer and Weld in State of Colorado and Counties of Albany and Laramie in State of Wyoming. Sources of information are U. S. Census reports and from Meteorological Reports of U. S. Government. These are official re-

2392 ports. Have made a diagram showing size of these four counties.

(Defendants' Exhibit 86, a blue print, offered in evidence.)

Defendants' Exhibit 86 is that diagram showing relative size of these counties. Obtained area in square miles from U. S. Reports. Diagram shows area of Laramie County, Wyoming, to be 6,992 square miles. That is the county as it was prior to 1910, containing I believe, Platte, Goshen and Laramie Counties as they are now situate. Whenever I refer to other plats in my testimony and speak of Laramie County I refer to Laramie County, Wyo., as it existed prior to 1910 and before the counties of Platte and Goshen were cut off.

In Exhibit 86 I show Weld County, Colo., to contain 3,918 square miles. That is present area of Weld County. It has been area since 1889. The original Weld County is shown by finer line to right generally of diagram representing Weld County at present.

2393 Morgan, Logan, Sedgwick, Phillips, part of Yuma and part of Washington Counties and present Weld County are all included in the original Weld County. There are seven new counties in whole or in part within original Weld County.

Original county of Larimer, Colorado, was divided in 1909. Jackson County was cut off. Jackson County includes that portion of Colorado commonly known as North Park.

Albany County, Wyo., runs through the diagram without changes. Have made diagram showing population of Weld and Larimer

Counties in Colorado and Albany and Laramie Counties in Wyoming.

(Defendants' Exhibit 87, a blue print, offered in evidence.)

Defendants' Exhibit 87 is the diagram mentioned. It includes decades from 1870 to 1910. On this diagram, population of Larimer and Weld Counties is represented by solid line and that of Albany and Laramie Counties by dot and dash line. Data obtained
2394 from United States Census reports. In 1870 population of Larimer and Weld Counties in Colorado, combined, was 2,474. Combined population of Albany and Laramie Counties in Wyoming was 4,978. The diagram contemplates the undivided county of Laramie, Wyoming. In 1870, Weld County was also undivided.

From line which designates year 1880 I have upper line labeled "population of Colorado counties if original area considered." That line shows population of Larimer and Weld Counties in Colorado including the counties which were taken from them. The other line, the solid line, shows growth in population in Weld County as it existed at that time, so whenever it was divided it was, of course, cut down some in population, but there was enough growth to more than make that up.

In 1910 population of present area within Counties of Larimer and Weld in Colorado was 64,477. Combined counties of Albany and Laramie, Wyo. (with Laramie County including present counties of Platte and Goshen) is 37,701. Both Wyoming and Colorado areas show increase of population. Wyoming counties are larger in point of population of 1870. Their increase in population
2395 has kept pace with Colorado counties until last 10 years. Within last 10 years Colorado counties have gone ahead. In 1900 Wyoming counties were ahead of Colorado counties in population, that is, total population; but in 1910 reverse is true. Very rapid increase took place in Colorado counties. By population of Colorado counties I refer to smaller areas of present counties. If original areas were taken population of Colorado counties goes beyond population of Wyoming counties between 1880 and 1890.

Weld County, Colorado, is at present a little smaller than Albany County, Wyo. The difference is a little less than 500 square miles.

Have diagram showing population of the two counties in comparison.

(Defendants' Exhibit 88, a blue print, offered in evidence.)

Defendants' Exhibit 88 is the diagram showing population of two counties in comparison. Covers decades from 1870 to 1910 inclusive. Divided area of Weld County is shown. Albany County, Wyo., had larger population in 1870. Population was, 2,021.
2396 Weld County, Colo., was not divided at that time, and had population of 1,636. Line showing division of Weld County commences at point indicated in years 1880. Leaving larger area of Weld County and referring to restricted area, Weld County was

larger in population in 1910. Weld County had 39,177 and Albany County, Wyo., 11,574.

There was decrease of approximately 1500 in population in Albany County, Wyo., from 1900 census to 1910 census. There has been no decrease in population of Weld County since 1870. Population of Weld County has increased since 1870 regardless of division of county. Increase greatest between years 1900 and 1910. Each decade has produced a more accelerated increase in Weld County with exception of decade from 1890 to 1900. During that decade growth was not quite as steady, although it continued pretty well. The increase in Weld County, however, was greater in proportion to population than increase in Albany County, Wyo.

2397 Have made examination of census reports for purpose of determining rural population, taking counties of Larimer and Weld as one in Colorado and counties of Laramie and Albany in Wyo. as one.

(Defendants' Exhibit 89, a blue print, offered in evidence.)

Defendants' Exhibit — is the diagram showing the rural population. It covers decades from 1870 to 1910.

In 1870 Wyoming counties had larger rural population. Rural population in Wyoming counties was 2,700. Rural population in Colorado counties was 1,994. In this diagram have also shown original area Weld County. Eliminating that and referring to present area of Weld County and also County of Larimer in Colorado, rural population of those counties in 1910 was 43,649. That of Albany and Laramie Counties, in Wyoming, was 18,144. Colorado counties' population passed numerically population Wyoming counties between 1870 and 1880. During these four decades there has been increase in rural population in these areas. Increase in Colorado counties is more rapid than increase in Wyoming counties. Greatest increase in population in both areas in last decade, 1900 to 1910. Increase population Colorado counties runs from 21,504 in 1900 to 43,649, practically double. Increase in Wyoming
2398 counties runs from 10,971 in 1900 to 18,144 in 1910. In other words, increase in this decade in Colorado counties was 22,145 and increase in Wyoming counties was 7,273. Increase in Wyoming counties was about one-third that of Colorado counties. There has been specific increase in population during last two decades in Wheatland District. Considerable portion of increased population in County of Laramie, Wyo., shown on my diagram, comes from settlement of Wheatland area.

Have prepared data showing acres improved farm land in counties of Weld and Larimer in Colorado and Albany and Laramie in Wyoming, treating each county separately.

2399 (Defendants' Exhibit 90, a blue print, offered in evidence).

Defendants' Exhibit 90 is diagram showing last mentioned matters. Information was obtained from U. S. Census reports. Covers decades form 1870 to 1910 inclusive. According to diagram, Weld County, Colo., is represented by solid line, also shown by

another solid line area of original Weld County. Larimer County, Colo., represented by line of dashes, Albany County, Wyo., represented by dot and dash line, Laramie County, Wyo., by dash and two-dot lines. Laramie County, Wyo., on this diagram includes area now contained in three counties of Laramie, Goshen and Platte. This is not restricted area of Laramie County. It does not show restricted area as far as Weld County, Colo., is concerned. That is case in all of these.

In 1870 there were 9,715 acres improved farm land in Weld County; 5,135 in Larimer County, Colo.; 184 acres improved farm lands in Albany County, Wyo.; 125 acres improved farm lands in Laramie County, Wyo.

2400 Referring to lines representing Weld County, Colo., I showed division at year 1880. Regardless of division at that time and to divisions made after that time, number of acres of improved farm lands in Weld County increased, in each decade except between 1890 and 1900, when there was very slight decrease. That was due to panic of 1893. That was period of very little development. With exception of that decade, country shows agricultural growth all the time. Between 1900 and 1910 acres of improved farm lands in county almost doubled. It increased from 251,307 to 410,346.

Albany County, Wyo., starts with 184 improved land in 1870. Acreage increases, but not as rapidly as Weld County, and increase runs on to 1900. There is decrease between 1900 and 1910, so that total acreage of improved farm lands drops from 149,075 to 107,315. Albany County, Wyo., shows decrease of 41,760 acres improved farm land from 1900 to 1910.

Larimer County, Colo., shows increase from 1870 to 1890, not as rapid an increase from 1890 to 1900, but a substantial increase, then slight decrease from 1900 to 1910, due to division of county. If original area were taken, we would have 252,262 acres improved farm land, but on account of division of county we have 177,525 acres in 1910. County division referred to was setting aside North

2401 Park under name of Jackson County. Taking area of county as a whole, without this deduction, there is no place in its history showing decrease of improved farm lands.

History of Laramie County in Wyoming shows increase in number acres of improved farm lands from 1870 up through 1880, a more rapid increase up to 1890, remarkable decrease from 1890 to 1900, more marked than those of any of the other counties, those were years of panic and shows rapid increase from 1900 to 1910 due to opening of Wheatland area.

Total acreage improved land in those counties shown by diagram, Albany County, Wyoming, 1910, was 107,315 acres; Laramie County, Wyoming, 210,993 acres, that includes the present area of Laramie, Platte and Goshen Counties. It also includes in part reclamation projects on North Platte River. Number improved farms lands in Larimer County, Colorado, 177,525 acres, considering county as divided. Without division it would be 252,262 acres.

Weld County, Colorado, has acreage of 410,345 acres. If original

area of Weld County were taken it would have 978,261 acres improved farm lands in 1910.

2402 The counties which were taken out of original county of Weld are in eastern portion of original county. Generally speaking, they are down South Platte River below junction of Platte and Poudre.

Have diagram showing number of farms in Larimer and Weld Counties, Colorado, and Laramie and Albany Counties, Wyo.

(Defendants' Exhibit 91, a blue print, offered in evidence).

Defendants' Exhibit 91 is diagram referred to. It represents number farms in four counties in question, Weld and Larimer of Colorado, and Albany and Laramie in Wyoming. Starting in 1870, we find greatest number farms in Larimer County, Colo., next, Weld County, Colorado, 121 in Larimer County, Colo., 105 in Weld County, Colorado. We find 20 in Albany county, Wyo., and 1 in Laramie County, Wyo. Diagram shows an increase in number of farms in all counties. Weld County increased more rapidly than any of others. Increase from 1870 to 1880, is not so rapid as from 1880 to 1900. The most rapid increase is from 1900 to 1910 for Weld County, Colo. Upper line marked "number for original area" is taken and shows number farms in original area of Weld County and division is shown as taking place in 1880. Rapid in-

2404 crease noted in Laramie County, Wyo., between 1900 and 1910 is due to development of Wheatland and North Platte areas.

In Albany County, Wyo., diagram shows in 1910, 453 farms.

Laramie County, Wyo., shows 1,933 farms.

Larimer County, Colo., if original area is taken, shows 2,008 farms. If divided area is taken, shows 1,830 farms.

Weld County, Colo., shows in present area 3,981 farms in 1910 and if original area is taken it would show 8,955 farms. During that decade there was great development in Weld County. Farms were split up in number of instances, making more farms, and then great deal of new territory was opened up. There has also been more intensive farming.

(Defendants' Exhibit 92 offered in evidence).

Defendants' Exhibit 92 shows *that* valuation improved farms in Weld County and Larimer County, Colo., and in Albany and Laramie counties, Wyo. Diagram covers period from 1870 to 1910. Marginal numbers at left show valuation in dollars. In 1870 valuation improved farms in Larimer County, Colo., was $278,580. For Weld County, Colo., $22,970. For Albany County, Wyo., valuation was $8,567. For Laramie County, Wyo., in 1870, valuation was $2,000 *dollars*. Valuation of $2,000 on Laramie County, Wyo., lands in 1870 is not shown on diagram.

It places Larimer County, Colo., above other three counties in 1870. It continues ahead until 1880 and between 1880 and 1890 Weld County valuation passes Larimer County, Colo., also valuation Laramie County, Wyo., goes ahead of Larimer County, Colo., and

Albany County, Wyo., is below them all. Between 1890 and 1900 Laramie County, Wyo., falls from $4,842,330 in 1890 to $3,932,450 in 1900.

Between 1900 and 1910 there is very rapid increase in Weld County, rapid increase in Larimer County, Colo., but not as rapid as in Weld County. There is about same rapidity of increase in Laramie County, Wyo., and not so rapid an increase in Albany County, Wyo.

In 1910 Albany County, Wyo., shows valuation improved farms of $7,592,886.

Laramie County, Wyo., shows $17,400,926.

Divided area of Larimer County, Colo., shows $19,071,431. Original area Larimer County, Colo., shows $21,839,856.

Present area Weld County, Colo., shows valuation of farm lands $45,001,628 and original area Weld County shows $77,041,935.

(Defendants' Exhibit 93 offered in evidence).

Defendants Exhibit 98 shows development irrigated area as far as was possible for me to obtain facts from United States
2406 Census reports. This diagram shows four counties again, Weld and Larimer counties, Colo., Albany and Laramie counties, Wyo. Beginning with 1890, was unable to find data concerning irrigated area at any time previous. Weld County, Colo., is at head of list in 1890 with 112,080 acres. Larimer County, Colo., shows second with irrigated acreage of 103,483 acres, which is not marked on plat.

These diagrams are drawn to scale. You can read it right off. A trifle above 100,000 acres is what plat shows.

In 1890 acreage irrigated in Albany County, Wyo., was 34,522 and in Laramie County, Wyo., was 33,553.

In all four counties we have increase between 1890 and 1900, more rapid in Weld County than any of others.

During decade between 1900 and 1910 we have another rapid increase in acreage of irrigated area in Weld County running up in 1910 to 395,514 acres. Larimer County, Colo., shows very slight increase between 1900 and 1910 due to division of county. If original area were taken it shows rapid increase, more rapid in fact than any of others, running up to 322,450 acres. With present area of county, we have in 1910, 170,600 acres of irrigated land.

2407 Albany County, Wyo., during decade from 1900 to 1910 shows increase running up to 151,926 acres.

Laramie County, Wyo., shows also increase running up to 122,021 acres in 1910.

Large part of Larimer County, Colo., is mountainous. Increase of only 1,572 acres in present Larimer county in 1910 was due entirely to setting off of large area of North Park, which is now known as Jackson County, Colo., and even with that taken away and placed in another county there is enough development to make increase in that last decade. Diagram for Larimer County for 1900 shows area of undivided county. Number of acres which were afterwards set

out in North Park, which were under irrigation at that time, would be deducted from 169,028, in order to show actual increase in remaining portion of county between 1900 and 1910.

(Defendants' Exhibit 94, a blue print, offered in evidence).

Defendants' Exhibit 94 is diagram representing value of all farm crops in Weld and Larimer counties, Colo., giving each one separately, and of Albany and Laramie counties, Wyo., giving each one separately.

Diagram runs from 1870 to 1910, inclusive. It shows that in 1870 value crops raised in Larimer County, Colo., is greatest of all four counties, amounting to $176,649. Weld County, Colo., comes second with value of $146,671. Albany County, Wyo., comes third with valuation of $29,700, and Laramie County, Wyo., comes fourth with valuation of $1,000.

There is increase in value of farm crops to be noticed in all four counties in decade 1880 to 1890, and decade 1890 to 1900, most rapid increase being in Weld County, Colo. In 1880 Weld County has gone ahead of all other counties, Larimer County, Colo., second, Laramie County, Wyo., third, and Albany County, Wyo., coming last.

There is more rapid increase in all four counties from 1880 to 1890 and still more rapid increase in Weld County, Colo., and Larimer County, Colo., between 1890 and 1900, also more increase in Albany County, Wyo., but less rapid increase in Laramie County, Wyo., for decade between 1900 and 1910.

2408 The greatest increase is in Weld County, Colorado. Value farm crops in that county in 1910, considering present area of county amounts to $7,256,601. If original area of Weld County is considered value farm crops produced in 1909 for the 1910 census gives $11,777,884.

Larimer County, Colo., comes second. Its present area being considered, value of farm crops produced in 1910 is $3,401,749. If original area is considered, it amounts to $3,728,380.

Laramie County, Wyo., in 1910 shows value of all farm crops to be $1,488,976.

Albany County, Wyo., during decade from 1900 to 1910, shows decrease in value of farm crops, falling off from $804,565 in 1900 to $586,157, in 1910.

That portion of Larimer County, Colo., now included in Jackson County is that section of state known as North Park. That is mountain park near headwaters of North Platte River. Principal crop raised there is native hay.

Comparison of diagram Exhibit 94 with Exhibit 93, particularly with reference to divided county of Larimer, Colo., shows that in decade from 1900 to 1910 there was large area irrigated in North Park but when it comes to valuation of crops produced, the value of crops does not correspond with the amount of acreage set off, so that decrease between valuation of farm crops of original area and divided area is not as great as decrease in irrigated area of
2409 land in original area and divided area. Difference in irrigated area in 1910 between original and present area of

county is 151,850 acres. Difference in value farm crops on same comparison for 1910 is $326,635.

This, then, shows that value of hay crops per acre on increased acreage in no wise compares with values of agricultural crops down in Poudre Valley region.

(Defendants' Exhibit 95, a blue print, offered in evidence).

Defendants' Exhibit 95 is diagram showing production of wheat, in Weld and Larimer Counties, Colo., and Albany and Laramie counties, Wyo. It shows total production in bushels.

Data runs from 1870 to 1910. In 1870 greatest amount of wheat was produced in Larimer County, Colo., amounting to 12,933 bushels. Second amount comes from Weld County, Colo., with production of 8,307 bushels. No wheat was grown in Laramie County or Albany County, Wyo., at that time according to the report.

1880 shows rapid increase in number of bushels of wheat grown in Weld County, running ahead of all other counties, Larimer County coming second, and no wheat in Albany County or Laramie County, according to the report.

1890 more rapid increase in Weld County than in any of others. A rapid increase in Larimer County, Colo. Laramie County, Wyo., shows production of 730 bushels with no production in Albany County, Wyo.

1900 shows still more rapid increase in Weld County, a decrease in Larimer County, Colo., slight increase in Laramie County, Wyo., and 770 bushels raised in Albany County, Wyo.

1910 shows decrease in wheat production in Weld County, Colo. Amount produced in present area of county amounting to 1,628,022 bushels. If original area Weld County is taken it shows increase to 2,499,425 bushels in 1910.

There is increase in Larimer County, Colo., and in 1910 there was produced 580,250 bushels of wheat.

Amount produced in Laramie County, Wyo., was 107,800 bushels in 1910.

Amount produced in Albany County, Wyo., was 4,068 bushels in 1910.

Cause of decrease of production of wheat in present county of Weld was due in last decade to raising of sugar beets. The acreage went into sugar beets instead of wheat. Sugar beets are more valuable crop than wheat.

(Defendants' Exhibit 96, a blue print, offered in evidence.)

Defendants' Exhibit 96 is diagram showing average yield of wheat per acre in four counties in question. It runs from 1880 to 1910—
for Weld and Larimer counties, Colo., and from 1890 to 1910
2411 for Laramie and Albany Counties, Wyo. It shows increase in
average yield per acre in two Colorado counties for each decade, starting in with average yield of 21.4 bushels per acre for Larimer County, Colo., in 1880 and 21.3 bushels per acre for Weld County in same year. An increase for each until 1910 it reached

an average of 29.3 bushels per acre for Larimer County, Colo., and 29 bushels per acre for Weld County, Colo.

For two Wyoming counties shows average yield per acre for Albany County in 1890 of 21 bushels per acre, rising to 22 bushels per acre in 1900, and a decrease to 14 bushels per acre in 1910. For Laramie County, Wyo., in 1890 average yield per acre was 18.6 bushels. In 1900 it was 17.2 bushels and in 1910 it was 13.3 bushels.

Averaging the decades it gives for period of 40 years in Weld County, Colo., 25.95 bushels per acre; for Larimer County, Colo., 25.3 bushels per acre; for Albany County, Wyo., for period of 30 years, 19.1 bushels per acre and for Laramie County, Wyo., 15.8 bushels per acre.

Average in Colorado counties for period of 40 years and Wyoming counties for 30 years. There are four census reports for Colorado counties and three for Wyoming counties.

If same average of 30 years were taken for Colorado counties as was taken for Wyoming counties, average for Colorado counties would be more bushels per acre.

Most remarkable thing shown in this diagram is increased yield per acre shown in Colorado counties. It shows decrease in Laramie County, Wyo., a continual decrease. Albany County, Wyo., shows slight increase and then very great decrease.

2412 Average yield is constantly increased in Colorado counties during 40 years and is decreased in Albany County, Wyo., during last decade and decreased in Laramie County, Wyo., during last two decades. I attribute high average yield per acre in 1890 in two Wyoming counties to be due to small acreage of wheat produced. There was very small acreage produced and it probably was in very advantageous position so far as new area is concerned, both for climate and moisture, and consequently with only few acres planted, it does not give as good average condition in county. As acreage increases yield falls off. I refer to 1890 in first case and 1910 with increased acreage as shown on previous diagram or in acreage an increased amount produced and consequently increased acreage. Diagram Exhibit 96 taken in connection with previous Exhibit 95, shows clearly what I have in mind.

To make comparison of Colorado counties with Wyoming counties for last two decades in average yield will state that, taking last three decades for Colorado counties gives for Weld County, 26.4 bushels per acre and for Larimer County 26 bushels per acre as average yield for these three reports. I would like to add here also that this is total yield of wheat, dry land and irrigated land, so that we take into consideration the whole yield and that cuts average yield down on irrigated acres. When I refer to average for decade I refer

2413 to report for each decade. Between years 1890 and 1910 have included reports for 1890, 1900 and 1910.

(Defendants' Exhibit 97, a blue print, offered in evidence.)

Defendants' Exhibit 97 shows total production of oats for Weld and Larimer counties, and Albany and Laramie counties, Wyo., in

bushels. Total yield of oats in bushels. This runs from 1870 to 1910 and we find:

1870, Larimer County, Colo., was producing greatest number of bushels of oats, 40,213. Weld County came next with 24,207 bushels. No oats were raised in Laramie or Albany counties, Wyo.

1870 to 1880 increase in production of oats, Weld County being ahead of all the others, producing 92,449 bushels, with Larimer County, Colo., producing 77,106 bushels. Laramie County, Wyo., produced 525 bushels and Albany County, Wyo., produced nothing.

1880 to 1890 there was increase in all four counties. Rapid increase in Colorado counties and slight increase in Wyoming counties.

1900 we find increase in production of oats for Weld County. Decrease in production of oats for Larimer County, Colo., slight increase in production of oats for Laramie County, Wyo., and decrease in production for Albany County, Wyo.

1900 to 1910 we find very rapid increase in production of oats in Weld County, Colo.; rapid increase in production of oats in Larimer County, Colo.; rapid increase in production of oats in Lara-
2414 mie County, Wyo.; it running ahead of Larimer County, Colo., and an increase in production of oats in Albany County, Wyo.

1910 present area Weld County produced 856,544 bushels of oats. If original area of Weld County were considered production would be 1,446,620 bushels.

Amount produced in Larimer County, Colo., was 514,553 bushels.

Laramie County, Wyo., produced 632,949 bushels.

Albany County, Wyo., produced 120,449 bushels.

Heavy increase from 1900 to 1910 in Weld and Larimer Counties, Colo., was at time when large areas were being devoted to sugar beets.

(Defendants' Exhibit 98, a blue print, offered in evidence.)

Defendants' Exhibit 98 shows average yield oats per acre Weld County, Colo., and compares it with average yield of oats in Laramie County, Wyo. It shows average yield of oats per acre in Weld County in 1880 to be 27.2 bushels, in 1890 to be 30 bushels, in 1900 shows 32.4 bushels and in 1910 to be 32.2 bushels. For 1890 Laramie County, Wyo. shows average yield oats per acre to be 23.25 bushels, 1900 to be 23.6 bushels per acre, and 1910, 21.6 bushels per acre.

2415 Taking last three reports for Weld County, Colo., and averaging them shows average yield to be 31.5 bushels per acre, and for Laramie County, Wyo., average yield to be 22.7 bushels per acre.

I took these two counties for comparison because they were the two high counties in production of oats.

(Defendants' exhibit 99, a blue print, offered in evidence.)

Defendants' Exhibit 99 represents number of bushels of barley produced in Weld County and Larimer County, Colo., and Laramie and Albany counties, Wyo. It runs from 1870 to 1910.

1870 Larimer County, Colo., led in production of barley, with Weld County, Colo., coming second and no production of barley in either of Wyoming counties. It shows increase in production of barley for two Colorado counties from 1870 to 1880 and rapid increase in production of barley in Weld County from 1880 to 1890. It shows slight decrease in production of barley in Larimer County, Colo., for that same decade, and shows still nothing produced in two Wyoming Counties at that time in so far as barley is concerned.

1890 to 1900 shows rapid increase in Weld County, rapid increase in Larimer County, very small production in Laramie, Wyo., and nothing produced in Albany County, Wyo. Do not have figures down here for that county but so far as diagram is concerned it shows nothing grown in Albany County.

1900 to 1910 shows rapid increase in production of barley
2416 in Weld County and increased production barley for Larimer County for this same decade. Also increase Laramie County, Wyo., but not so rapid as in either of two Colorado counties, and increased production of barley in Albany County, Wyo., but very little produced even at that.

1910 production of barley for Weld County, Colo., present area, 577,637 bushels. Original area considered, 760,452 bushels. For Larimer County we have 179,847 bushels barley produced. For Laramie County, Wyo., 21,946 bushels of barley, and for Albany County, Wyo., 10,361 bushels of barley.

(Defendants' Exhibit 100, a blue print, offered in evidence.)

Defendants' Exhibit 100 represents average barley yield per acre in Weld County, Colo., and Laramie County, Wyo. These are the two high counties in their respective states in the production of barley. They also adjoin each other at the interstate line. Diagram gives yield per acre for period covered by four reports in so far as Weld County is concerned, and for three reports, 1890 to 1910, in so far as Laramie County, Wyo., is concerned.

(Defendants' Exhibit 101, a blue print, offered in evidence.)

Defendants' Exhibit 101 represents number of bushels of potatoes produced in Weld County, Colo., Larimer County, Colo., Albany County, Wyo., and Laramie County, Wyo.

2417 Diagram runs from 1870 to 1910 inclusive. Shows that in 1870 Larimer County, Colo., was producing greatest number of bushels of potatoes amounting to 26,074; Weld County coming second with production of 8,065 bushels; Laramie and Albany Counties, Wyo., producing no potatoes.

1870 to 1880, Weld County goes ahead in production of potatoes and counties come in following order: Larimer County, Colo., Laramie County, Wyo., and Albany County, Wyo.

1880 to 1890 increased production of potatoes in Weld County, Colo., then comes Laramie County, Wyo., then Larimer County, Colo., and Albany County, Wyo., with very small yield comparatively speaking in comparison with Weld County.

1890 to 1900 there is very heavy increased production of potatoes

in Weld County, an increased production of potatoes in Larimer County, Colo., and slight decrease in production of potatoes in Laramie County, Wyo., with very small production in Albany County, Wyo.

1900 to 1910, very rapid increased production of potatoes in Weld County, Colo., amounting to 5,867,691 bushels for county as it exists as present. Taking original area Weld County it is some higher, I have not it marked but can read it off approximately from scale, it is about 6,300,000 bushels. Production of potatoes in Laramie County, Wyo., comes second, being 203,016 bushels. Larimer County, Colo., comes third with production of 198,506 bushels. Albany County, Wyo., comes last with about 43,729 bushels of potatoes.

(Defendants' Exhibit 102, a blue print, offered in evidence.)

Defendants' Exhibit 102 shows average yield potatoes per acre for Weld County, Colo., and Laramie County, Wyo. These are taken because they are the two leading counties of the four under consideration.

I have three reports for each county, 1890, 1900 and 1910. Taking these three reports and averaging them, we obtain the average yield of potatoes per acre for Weld County, Colo., of 107.4 bushels; average yield for Laramie County, Wyo., of 57 bushels per acre.

1890 the counties started out very closely together; Laramie County, Wyo., running 44.5 bushels per acre, approximately reading from diagram, and Weld County, Colo., about 49 bushels per acre, showing rapid increase in average yield per acre for potatoes in Weld County to 1900 and increase continuing but not so rapid to 1910. It shows decrease average yield per acre for potatoes in Laramie County, Wyo., for 1900 and increase in 1910.

1910 average yield for Weld County was 151.8 bushels per acre. For Laramie County, Wyo., the average yield was 88 bushels per acre.

2419 (Defendants' Exhibit 103, a blue print, offered in evidence).

Defendants' Exhibit 103 shows tons of hay produced in Weld County, Colo., and Larimer County, Colo., also Albany and Laramie Counties, Wyo. It covers production of hay as shown by census reports from 1870 to 1910 inclusive.

1870 Weld County was producing the most hay. Larimer County, Colo., and Laramie County, Wyo., were producing practically same amount at that time. Albany County, Wyo., was lowest of four counties.

1870 to 1880 Weld County shows increased production of hay, then more rapid increase from 1880 to 1890, and that degree of increase continues from 1890 to 1900 and then from 1900 to 1910 an increase but not so rapid as previously. Larimer County shows increase from 1870 to 1880, more rapid increase from 1880 to 1890, still more rapid increase from 1890 to 1900 and decrease from 1900 to 1910. That is due to division of county, cutting off large hay

producing area commonly known as North Park, now Johnson County.

Laramie County, Wyo., shows increased production of hay from 1870 to 1880, but not as rapid increase as either Weld or Larimer counties in Colorado. Shows a more rapid increase from 1880 to 1890, about the same degree of increase from 1890 to 1900, and an increase, more rapid than any other period, from 1900 to 1910. Albany County, Wyo., shows more rapid increase from 1870 to 1880 than either Larimer County, Colo., or Laramie County, Wyo. In 1880 it stood second in all counties in production of hay. That increased from 1870 to 1880, and was practically maintained throughout next decade.

2420 1880 to 1890 other increased more rapidly, going beyond Albany County in production of hay in that decade. Albany County shows more rapid increase from 1890 to 1900 than in two preceding decades, but not as rapid as other three counties, 1900 to 1910 increased hay production of Albany County falls off and we have an increase but not as marked as in preceding decade.

Albany County, Wyo., total production hay in 1910, 52,748 tons.

Larimer County, Colo., with North Park area deducted, 109,792 tons. Not considering divided county of Larimer, we have production of 175,040 tons.

Laramie County, Wyo., shows 116,700 tons hay.

Weld County, Colo., with present area, shows production of 168,214 tons and for original area Weld County the production would be 280,181 tons.

Referring to line indicating present County of Weld, account for lack of same ratio of increase to production of sugar beets. Alfalfa is crop that has been plowed up to great extent for production of beets. Present county of Larimer is affected the same way.

Under the classification of hay I have included both native hay and alfalfa. It is given in census reports as total hay production.

2421 (Defendants' Exhibit 104, a blue print, offered in evidence.)

Defendants' Exhibit 104 represents number live stock in Larimer and Weld counties, Colo., and Laramie and Albany counties, Wyo.

Term "live stock" includes cattle, sheep, swine, asses, mules and bulls, separately listed. I have summed them all together.

Diagram runs from 1870 to 1910 inclusive. It shows in 1870 Albany County, Wyo., had greatest number of live stock, 14,980; Larimer County, Colorado, second in number, 6,155; Weld County, Colo., third, 5,643; Laramie County, Wyo. fourth, 25.

Laramie County, Wyo., shows marked increase from 1870 to 1880, and same increase practically continues to 1890. From 1890 to 1900 there is increase but not so rapid. From 1900 to 1910 a more rapid increase.

Albany County, Wyo., shows marked increase but not as great an increase as Laramie County, Wyo., between 1870 and 1880. A decrease from 1880 to 1890. Then rapid increase from 1890 to 1900; slight increase from 1900 to 1910.

Weld County, Colo., shows increase from 1870 to 1880, which is comparable with Albany County, Wyo.; decrease is shown from 1880 to 1890; increase from 1890 to 1900 and slight decrease from 1900 to 1910.

Larimer County, Colo., shows increase from 1870 to 1880. Shows slight decrease from 1880 to 1890, increase from 1890 to 1900 and decrease from 1900 to 1910.

2422 Laramie County, Wyo., in 1910 shows 552,153 head of live stock.

Albany County, Wyo., same year shows 199,103 head live stock.

Weld County, Colo., same year shows 84,850 head live stock, present area. Considering original area shows 273,296 head.

Larimer County, Colo., for same period shows 49,753 head live stock.

Laramie County, Wyo., is large sheep producing district.

Defendants' Exhibits 86 to 104 inclusive, were prepared by me. Data for these Exhibits was taken from the U. S. Census reports.

Summing up, showing made by Exhibits 86 to 104, inclusive, they show that the Weld County and Larimer County, Colo., are agricultural counties and that Laramie county and Albany County, Wyo., are stock producing counties.

I have made examination of meteorological records for purpose of comparing climate of Weld County, Colo., with climate of Albany County, Wyo. Obtained data from government meteorological reports. From stations of Laramie, in Albany county, Wyo., and at Greeley, Colo. Station at Laramie, in Albany County, Wyo., is connected with experiment station at that point.

Temperature records were taken by what we call the self-registering thermometers, which are housed in little houses with slat sides so as to do away as much as possible with effect of radiation.

2423 They are placed that way, as I understand it, for purpose of comparison. For instance, in city of Fort Collins, we have instruments at college housed in this way. We also have self-registering instruments outside, 6 inches above ground. There are other place- in city where instruments of similar nature are owned and operated. Those that are housed are not materially affected with radiation. Temperatures obtained from these instruments are more nearly comparable than outside instruments near ground. It is for that purpose, I believe, they specify housing of instruments in that way. That is plan generally adopted by United States

2423 through its Weather Bureau. These records were taken in same manner at both Greeley and Laramie.

(Defendants' Exhibit 105, a blue print, offered in evidence.)

Defendants' Exhibit 105 is plot showing minimum temperatures throughout year for two stations mentioned, Greeley, Weld County, Colo., and Laramie, Albany County, Wyo. It was taken from temperatures which were taken from thermometers registering minimum temperatures from government records.

Minimum temperatures were selected instead of maximum tem-

peratures, because I desired to show relatively length of season above frost in each of two counties.

(Defendants' Exhibit 105 offered in evidence with qualification that chart marked Exhibit 105 covers years 1893 to 1902 inclusive, and has been extended to show succeedings years up to and including 1912, but chart has not been prepared for print and said chart when printed will be substituted on enlarged chart for Exhibit 105, witness will testify from originals.)

2424 Defendants Exhibit 105, dotted line running all way through shows temperatures. It is line showing minimum temperatures for each month as given for Laramie, Albany County, Wyo. Solid line shows minimum temperatures as given by reports for Greeley, Colorado. Chart is graded to show temperatures −30 to +60 Fahrenheit. At point designated +30, heavy line running transversely across sheet indicates temperature of 43 degrees Fahrenheit, freezi' g; where temperature lines run above this freezing line it indicates that if line is wholly above during that month, there was at no time a temperature as low as freezing. Referring to Exhibit and record of successive years commencing with 1893, with comparison of temperatures above freezing at the two stations and length of period during which there was no temperature as low as 32 degrees above zero, we find:

Weld County, Colo., during June, there was at no time a temperature below 32. During month of July there was no time temperature below 32 degrees, in fact, minimum temperature for July was 44 degrees. During August minimum temperature was 34 degrees. During September temperature dropped below freezing line.

2425 Station at Laramie, Wyo., during June, early part of month there was temperature below 32 degrees, at least once, and may have been more. It was extreme minimum that I plotted. During July there was temperature during that year just 32, minimum temperature. During August there was temperature as low as between 24 and 23 degrees.

Comparing two records I figured that there was period of about three months and one week in Weld County, Colo., where the temperature was above 32, and one month and three weeks in Albany County, Wyo., where at all times temperature was above freezing. I have noted on map 90 days in 1893 when temperature at no time in Weld County, Colo., dropped below freezing; 48 days when temperature at no time dropped below freezing, at Laramie City, Wyo.

In year 1894 there were 108 days in Weld County, Colo., when temperature was above freezing and 75 days in Albany County, Wyo.

1895 there were 97 days for Greeley, Weld County, Colo., and 45 days for Laramie, Albany County, Wyo., when temperature was above freezing.

A peculiarity of temperature line for Laramie City, that year, 1895, is that it shows heavy frosts in June and heavy frosts in early part of August. You will also note that in that particular year there

was frost in Weld County, Colo., in early part of August, earlier than usual.

Year 1896 there were 130 days when temperature was above freezing at Greeley, Weld County, Colo., and 70 days at Laramie, Albany County, Wyo.

In year 1897 there are 138 days when temperature was above freezing at Greeley, Weld County, Colo., and 48 days at Laramie City, Wyo.

2426 For year 1898 there are 124 days when temperature was above freezing at Greeley, Colorado, and 75 days for Laramie City, Wyo.

For year 1899 there are 127 days when temperature was above freezing at Greeley, Colorado, and 70 days for Laramie City, Wyo.

For year 1900 there were 130 days when temperature was above freezing at Greeley, Colorado, and 80 days when temperature was above freezing at Laramie City, Wyo.

For 1901 there were 140 days when temperature was above freezing at Greeley, Colorado, and 80 days at Laramie City, Wyo.

For year 1902 there were 120 days when temperature was above freezing at Greeley, Colorado, and 50 days at Laramie City, Wyo.

For year 1903 there were 111 days at Greeley and 85 days at Laramie City when temperature was above freezing.

For year 1904 there were 128 days at Greeley when temperature was above freezing, and it frosted every month in the year at Laramie City, Wyo., so that the record stands at zero.

For year 1905 there were 128 days at Greeley, Colo., and 51 days at Laramie, Wyo., when temperature was above freezing.

For year 1906 there were 153 days at Greeley, Colo., and 61 days at Laramie, Wyo., when temperature was above freezing.

For year 1907 there were 153 days at Greeley, Colo., and 66 days at Laramie, Wyo., when temperature was above freezing.

For year 1908 there were 151 days at Greeley, Colo., and 18 days at Laramie, Wyo., when temperature was above freezing.

For year 1909 there were 132 days at Greeley, Colo., and 85 days at Laramie, Wyo., when temperature was above freezing.

For year 1910 there were 127 days at Greeley, Colo., and 40 days at Laramie, Wyo., when temperature was above freezing.

For year 1911 there were 132 days at Greeley, Colo., and 65 days at Laramie, Wyo., when temperature was above freezing.

For year 1912 there were 117 days at Greeley, Colo., and 40 days at Laramie, Wyo., when temperature was above freezing.

This makes average for 20 years of 126½ days for Greeley, Weld County, Colo., and 57.6 days for Laramie, Albany County, Wyo., when temperature was above freezing.

General view of record for 20 years shows that minimum at Laramie even through period when temperatures were above freezing, was always lower than minimum at Greeley. In other words, summer temperatures indicated by summer temperatures at Laramie, are always lower than at Greeley. This is true with one

exception, in 1903, when minimum temperatures in August at Greeley was lower than minimum temperature at Laramie.

Temperature of 32 degrees Fahrenheit recorded by thermometer placed inside of one of these little thermometer houses, does not necessarily indicate killing frost. It usually does, however,
2427 because records of temperatures at 6 inches above ground as shown by our station at Fort Collins, show that the minimum temperatures thus recorded register from 6 to 8 degrees lower with these thermometers than temperatures obtained and recorded in thermometer houses. Crop growing on ground would be affected by these outside or lower temperatures.

Minimum temperature recorded near ground is from 6 to 8 degrees lower than minimum temperature recorded in thermometer houses. This is the experience of the record of station maintained at Fort Collins, where we have the two thermometers. Probability is that freezing temperature indicated by thermometer in house is indicative of lower temperature obtained close to ground.

Probability is that temperature of 32 degrees recorded in temperature house is indicative of a killing frost on the ground. Difference of temperatures recorded between thermometer in house and one at ground would be relative to line indicated on chart 105. Chart necessarily shows relative comparison. You cannot declare with absolute definiteness that there are so many days between killing frosts, but comparing temperatures between two places taken by accurate thermometers under like conditions, relative temperatures are shown, and relative length of season is also shown. Relative differences in temperatures throughout the seasons is
2428 also shown. I wish it understood that number of days given here is taken from scale and may vary a little one way or another. Period indicated may be a little too long or a little too short and may not show exact number of days between frosts, but does show relative comparison between two places. Any error would be compensating and taking period of 20 years, we have very fair estimate of length of season.

Temperature lines on Exhibit 105 indicate minimum monthly temperatures.

Direct*ion*-examination, continued, by Mr. Delph E. Carpenter:

I stated that Exhibit 105 shows not only minimum monthly temperatures at Laramie, Wyo., and Greeley, Colo., but also gives idea of difference in temperatures during growing season.

During 1913, I made practical observations on ground relative to difference in growing seasons of these two areas. I obtained plans of cutting of alfalfa and of harvest of grains around Fort Collins and Eaton in Cache la Poudre Valley, and made some observations during July in Albany County, Wyo. Latter observation was as to development of crops.

2429 Alfalfa and native hay are perennial crops. Alfalfa is about as fair a crop as could be selected for demonstration of growing seasons of two areas.

First cutting alfalfa in Eaton district, Weld County, Colo., began

May 26th on farm Charles Camp. Yield 1½ tons per acre. On property of Bruce G. Eaton, foremen reported crop ready to cut June 6th and cutting began June 10th. In their opinion first cutting usually begins one year with another, from June 5th to June 10th. Cutting on farm of George Nusberger, 4 miles east of Eaton began May 28th, in 1913. Yield 2 tons per acre. First cutting Wm. McClelland, southeast of Eaton 5 miles, May 27th in 1913. R. M. Haythorn began June 16th and reports crop ready and ripe for cutting earlier. Fred Mimmack reported first cutting June 12th. Yield 2 tons per acre.

In Fort Collins district, first cutting of alfalfa began on farm C. P. Chandler on June 12th. Interviewed a number of
2430 farmers in that district. Time of first cutting ranged from June 12th to June 20th. Time of first cutting in Fort Collins district is about 10 days later than in Eaton in year 1913. The farm belonging to Bruce G. Eaton represents many thousand acres under Larimer and Weld Canal. It comprises estate of former Governor Eaton.

June 7th or 8th is average date of first cutting of alfalfa in Eaton district during year 1913. It was about one week or ten days later in Fort Collins district.

Was in valley of Big Laramie River during time of first harvest of first cutting alfalfa on Hart Ranch. That was on July 16th and July 17th, 1913. They were also putting up hay on Grable Ranch. This was first cutting alfalfa.

Defendants' Exhibit 106 is photograph I took of Hart Ranch, July 17, 1913, showing hay in stack, first cutting alfalfa, and at time of taking picture on this ranch they were putting up
2431 Hay. Hart Ranch is located above Laramie City on Laramie Plains. I also noted number of hay stacks shown in picture. These stacks are very much scattered. There are not many of them as on ground having great amount of hay. Stacks are much smaller than they make them in Poudre Valley. This is demonstrated by size of man standing to left of first stack in foreground in picture. I am comparing with stacks in similar field where 2 ton harvest has been made near Eaton.

Defendants' Exhibit 107 is photograph showing first cutting alfalfa on Grable Ranch on S. E. ¼ of Sec. 17. Tp. 14 N., R. 75, W., on Laramie Plains, taken July 16, 1913. Land irrigated under Fischer Ditch. They had finished stacking hay on that ranch at time photograph was taken. It evidently had been completed for few days only. There was no indication of second growth as yet. It was stubble. By comparison of two photographs it will be noticed that stand was not nearly so good on this as on Hart's ranch. Quantity of hay cut and put up was not so large. There are only three stacks shown in whole view of range of camera, and it was best photograph I could get at time I was there. Stacks were very small and yield had not been heavy. Size of stacks can be ascertained by comparison with size of man in foreground in picture. This

man would weight about 174 pounds and stand about 5½
2432 feet tall.

These two fields of alfalfa were the best that we saw, by far, in the Laramie Plains region. We traveled very much over the irrigated area on this trip.

(Defendants offer in evidence their Exhibits 106 and 107, photographs.)

Perennial crop like alfalfa is indicative of differences of growing season because plants simply develop as season develops, and mature with season. An early season would mature an early crop of alfalfa. Seeding has nothing to do with it.

Observations made by me of growth of this perennial plant, alfalfa, for year 1913, compare very favorable with observations noted on my temperature chart, Exhibit No. 105. The observations made on the ground confirm the deduction shown on Exhibit 105.

Made observations of dates of barley harvest on various farms in Poudre Valley, principally near Eaton, Colo. These observations show:

Barley harvest near Eaton, Colo., began July 11th to 15th, 1913. I saw number of fields that were being harvested at time I was there on July 19th and took picture of one. From observations by me and assistants I obtained the fact that barley harvest on farm of C. W. Gavin, Eaton, Colo. began July 15th, 1913; On ranch
2433 R. D. Hughes began July 16th; Farm B. C. Nix began July 5th; Ranch A. T. Searles began July 9th; Ranch Asa Decker began July 19th.

Average date barley harvest Eaton district would occur between July 5th and July 15th. Dates obtained by me were fair example of the beginning of barley harvest in that region. On July 19th there were many fields where barley was harvested and in shock.

Defendants' Exhibit 108 is photograph taken by me of barley harvest in field about one mile east of Eaton, July 19, 1913. Field was on N. ½ of Sec. 6, Tp. 6 N., R. 65, W. Binder was working in field; cutting was just being completed. It was a large field and practically all of barley was in shock. Yield was quite heavy.

(Defendants' Exhibit 108, a photograph, offered in evidence.)

On July 16, 1913, observed no fields of barley in process of harvest on Laramie Plains. I took photographs of grain that was growing. Took photograph of two best rye fields I saw in valley and also photograph of barley on ranch of Mr. Grable, which was just heading out at that time. It was very spotted, heading out in places. That photograph was not a success but rye picture was.

2434 Defendants' Exhibit 109 is picture of rye field on farm of Chris Olson, situate on N. W. ¼ of Sec. 24, Tp. 14 N., R. 76 W., taken July 16, 1913, by me. Rye was thin, of sparse growth all over field and just beginning to head out.

Defendants' Exhibit 110 is photograph of oat field showing

growth and development of oats and soil conditions in N. ½ of Sec. 4, Tp. 14 N., R. 76 W., taken by me July 16, 1913. Oats were very sparse on field. Field was very stony. Stony condition can be noticed by comparing it with hat that is lying in foreground in field. Plants were coming up between stones.

(Defendants' Exhibits 109 and 110, photographs, offered in evidence.)

July 16, 1913, while on trip on Laramie Plains, observed growth of grain wherever I saw it for purpose of comparison of growth with like grain in Poudre Valley. Alfalfa had at that time just
2435 been cut on Laramie Plains. Rye and barley was not ready for cutting. Plants showed late season, just as did first cutting of alfalfa. Would say that grain showed about same relative lateness. Was not there when any of grain was harvested. This was observed by McAnelly, or one or two engineers who were associated with him on the survey. They will testify to this fact subsequently.

Visited Wheatland district, July 17, 1913. Crop development in that region was much better than on Laramie area, but not so good as in Cache la Poudre area.

Crop development on Wheatland area was about midway between crop development on Laramie area and Poudre area. This was evidenced by maturity of crops at time we were there.

Considered soil conditions in Laramie Plains region primarily from agricultural values. Examined soil and took number of soil samples in different places in valley. During trip visited portion of Laramie Plains situate between river and Lake Hattie, and east of Lake Hattie Supply Canal, or Lake Hattie Inlet Ditch. Observed soil conditions in that region. Surface of land was gen-
2436 erally comparatively smooth and the lay of the land was very good. Slope was good for application of water. From mere superficial examination of area as we went along the usefulness for agricultural purposes appeared to be good. Further examination of the soil demonstrated the soil to be very poor. It consisted of thin top soil underlayed with bed of gravel, and top soil filled with boulders varying in size from robin's egg to as large as your two fists. The latter I would designate as boulders. I took photograph of soil in the vicinity of Lake Hattie Inlet, in field of oats, and this is shown on Exhibit 110, and there is another picture showing depth of surface soil where Lake Hattie Inlet cuts through country.

Defendants' Exhibit 111, is photograph of Lake Hatite Inlet, showing soil conditions through which cut is made. Taken in Sec. 20, Tp. 14 N., R. 76 W., by me July 16, 1913.

Photograph is taken to call attention to thin surface soil and boulder bed underlying it. Thin top soil runs from 1 foot to 1½ feet in thickness. In some places it is perhaps 2 feet in thickness. This canal is of recent construction. The soil noted in Ex-
2437 hibit 111 is the same soil of which surface conditions are noted in Exhibit 110.

Defendants' Exhibit 112, is a photograph taken by me July 16, 1913, on farm of E. A. Watson on Sec. 22, Tp. 14, N., R. 76 W.

It shows excavation being made for cellar. Shows stony condition of soil. He had pierced surface layer and was just into boulder layer below. Ground was wet in bottom of excavation, showing water table very close to bottom of cellar. Excavation was about 2½ feet to 3 feet in depth. Mr. Watson is shown in distance.

(Defendants' Exhibits 111 and 112, photographs, offered in evidence.)

Defendants' Exhibit 109 also shows soil conditions. It shows same boulder condition of soil as we noticed in practically all of pictures offered thus far.

Defendants' Exhibits 110 and 111 show what is designated by U. S. Geological Survey Maps as Laural Sandy Loam. Soil conditions further down toward Laramie are better than conditions shown in Exhibits 109, 110, 111 and 112. Surface soil seems to be deeper.

2438 There is considerable gravel in soil throughout the entire region. Best field I noticed was on Hart ranch. On this ranch best soil conditions were found and best soil sample was obtained. We did not make soil sample examination of soil at Agricultural College experiment station at Laramie.

Second growth or cutting of alfalfa harvested near Eaton, Colo., during 1913, beginning July 14th. Cutting began about July 16th near Fort Collins.

Second cutting alfalfa on Eaton estate near Eaton Colo., began July 14th, 1913. It was ready for harvest on July 8th.

Second cutting of alfalfa in Poudre Valley, near Eaton in 1913 began about same time as first cutting of alfalfa on Laramie Plains.

From my observations I would state that in my judgment the Laramie Plains region is not an agricultural section. The reasons for that opinion are the short growing season, low temperatures, poor and thin soil. Yield as shown by data in census reports would point to fact that it is not what you would term an agricultural section.

It is generally recognized that it costs approximately as much to produce a poor crop as it does a good crop on any given area.

2439 Value of country for agricultural purposes depends upon crop it will produce.

Net crop returns give value to country for agricultural purposes. I procured data for harvest of wheat and oats in Poudre Valley during 1913. Have notation of harvest of winter wheat 3 miles southwest of Fort Collins on July 9th on farm of W. O. Johnson. Harvest winter wheat E. E. Larson 1 mile southeast of Fort Collins July 12th. Do not have data for harvest of spring wheat with me, but it ran about 10 days or two weeks later than harvest of winter wheat. Reports gathered around and about Eaton show harvest of spring wheat about last of July. Oats harvested about one week earlier. Those are dates when harvest began. Harvests extend- over considerable time throughout summer. Continues two or three

weeks. Dates I gave are of first cutting. Oats were spring
2440 oats. Winter wheat is not raised around Eaton to any extent. Data I obtained there was with relation to harvest of spring wheat.

While visiting Laramie Plains went over Riverside Ranch and took soil samples. Hay meadows on that ranch were not very uniform. Would call them spotted. By spotted I mean that in places *there* were evidently producing small yield. In other places production of hay would be heavier. I saw nothing on Laramie Plains that would compare with meadow lands of Poudre Valley in production of hay. They would not yield so much. Do not think Laramie Plains meadows would yield more than ¾ to 1 ton per acre. Yield heavier in Poudre Valley. I refer to meadows where more native hay is raised.

E. B. HOUSE.

2441 Cross-examination by Mr. N. E. Corthell:

The charts numbered Exhibits 86 to 104 inclusive were made from Federal Census Reports and are simply translations of the statistical figures into graphic form, involving no analysis of the reports nor investigation of the basis upon which they are made. I did not know that since 1870 there has been frequent and great changes in the boundaries of Albany and Laramie Counties in Wyoming. I knew that two new counties had been organized out of Laramie County, but I did not know about any others. The comparisons of the different census reports are then merely nominal. The lines shown on the charts indicate absolute increase or decrease, and not the percentage of increase or decrease. I do not know whether a consideration of the percentage of change would make any radical difference in the result. The number of farms in Albany County, Wyoming, increased from 20 in 1870 to 453 in 1910, and in Laramie County, Wyoming, from 1 in 1870 to 1933 in 1910. In Weld County, Colorado, the increase was from 105 in 1870 to 3,981 in 1910, so that the percentage of increase was greater in Wyoming counties than in Colorado. In giving figures in regard to the wheat production in Wyoming and Colorado I have made no distinction between irrigated land and dry farm land. I have understood that there has been considerable dry farming in Wyoming in the last ten years, and this would probably reduce the average production per acre. I do not know how much dry farming there is in Laramie County, Wyoming, nor what part of the grain production is upon such land.

2445 I cannot give the average acre yield of oats for Albany County, Wyoming and Larimer County, Colorado, for 1910, as my graph upon that subject was limited to Laramie County, Wyoming, and Weld County, Colorado, which had the higher yields for their respective states. I did not purposely omit to show the average yield per acre of oats in Albany County, Wyoming.

2446 In preparing these charts I did not take into consideration the statement of the census bureau that the figures for the dif-

ferent censuses are not entirely comparable on account of variation from census to census in the definition of farm land and improved farm land, because I thought it fair to suppose that the same instructions in regard to any one census would be filed in both Wyoming and Colorado, so that the relative amount would be about the same.

2448 The census reports show that in 1870 there were more people in the Wyoming counties than in the Colorado counties, and that in Wyoming it was found that agricultural development was not as successful as stock raising, and the stock industry has therefore shown a big increase in Wyoming, while agriculture has shown a big increase in Colorado. Although I knew that there was this difference I did not realize its extent until I examined these census reports. I knew that a large part of the farm products in Wyoming is fed to livestock, but I made no investigation to ascertain whether this fact was taken into account in making up the Census reports. If a considerable quantity of grain is fed to stock in Wyoming without threshing returns being available this would affect the report as to the total yield, but I do not believe it would affect the report as to the average yield, as the acreage from which such crops were procured would not be included in the Census report. I do not know positively whether this is true or not. I endeavored to procure from the Census reports data relative to the value of livestock produced and marketed, but was unable to do so as variations are too great. I do not believe that I could now succeed in any such examination.

2449 I could not secure satisfactory data relative to the production of alfalfa, for in the earlier Census reports no distinction is made between alfalfa and native hay.

2450 The charts showing temperature which I have introduced have been made for the sole purpose of showing the minimum temperature from month to month and lines have been drawn from point to point showing the lowest temperature in each month with no attempt to show the minimum each day. Any error which arises through the use of this system would be compensating. Temperatures frequently occur considerably below freezing point without perceptibly damaging vegetation, and the damage is

2451 different with different kinds of crops. I would say that if the temperature is 26 degrees it would be a killing frost with respect to all farm crops. I would not say that a temperature 8 degrees below freezing would kill all crops, but it would injure them and stop further development. I do not believe that wheat just headed subjected to a temperature of 24 or 26 degrees would ever head out. I do not consider alfalfa as a crop of which to make comparisons with all agricultural conditions, but it is a crop by which to compare the seasons of two different locali-

2452 ties. The one visit I made to the Laramie Plains with a view to examining agricultural conditions was for three days in July, 1913. At that time we took five or six soil samples. We made no photographs other than those offered in evidence. On the last day of the trip we visited the Wheatland area, being the

2453 only time we went there. When we were on the Laramie Plains the cutting of the alfalfa had been going on for a few

days, I do not know how long, and I have no other knowledge as to the usual date of the first cutting of alfalfa.

Redirect examination.

2453 By Mr. Delph E. Carpenter:

A large percentage of grains raised in Weld and Larimer Counties in Colorado are also fed to live stock. This is particularly true of barley and oats. Some rye is fed.

2454 JOHN L. ARMSTRONG, a witness in behalf of defendants.

Direct examination by Mr. Delph E. Carpenter:

John L. Armstrong, Water Commissioner of District No. 3, State of Colorado. District No. 3 includes Cache la Poudre River and its tributaries. Have been water commissioner or acting water commissioner 24 years. This covers period of 31 years. Was in office 7 years during the 31 years.

Duties of water commissioner are to distribute water of river to ditches and reservoirs of district according to decreed rights as determined by District Court. I am local water officer for the district. My immediate superior is the Division Engineer of Division No. 1.

2455 Division No. 1 includes the entire drainage area of South Platte River and its tributaries. It is subdivided into water districts. I am commissioner of water district No. 3 in this division. Division Engineer is chief over entire water division.

State Engineer, Mr. John E. Field, at present is superior officer to Division Engineer. He is the chief official over all divisions and sub-divisions and districts throughout the state.

My duties have nothing to do with the fixing of priorities on stream. This is done by District Court. Statute provides that this court shall establish these priorities. I execute the decree.

Began as official in 1883. Was acting commissioner during absence of commissioner. Acted as deputy water commissioner during years 1883 to 1886. B. S. Lagrange was water commissioner during those years. He was absent part of the time. I was on active duty those years in irrigating season.

2456 Became Water Commissioner for district March 1887. Continued until April, 1889. Again became commissioner July 1, 1890 and continued until May, 1893. Again became commissioner January 1, 1895 and remained until April, 1889. Again became commissioner April, 1903 and have continued until present time. During these years that I have been water commissioner have resided at or near La Porte in water district No. 3 near Fort Collins.

During years when was not in office have been working for some of irrigation companies generally and have been in close touch with irrigation matters. Have had intimate knowledge, both officially and otherwise, of Cache la Poudre River since 1883. During all these years have not been absent from valley more than a day

or two at a time. Prior to 1883 had practical experience in
2457 application of water. Began irrigating in 1873. Became practical irrigator prior to becomeing deputy water commissioner. Had experience as superintendent of canal before becoming deputy water commissioner. Had charge of Larimer County Canal No. 2. The one I refer to is on opposite side of river from Larimer County Ditch. It heads perhaps three miles further down the stream and goes past Fort Collins on south and west and irrigates what we call Harmony District. The Larimer County Canal comes out on the north side of the river not far below north of canon and irrigates lands north and east of Fort Collins, Windsor and Eaton and over into Lone Tree Valley. This latter canal is the one owned by The Water Supply and Storage Company.

Official duties have placed me in position to observe general irrigation development in Cache la Poudre Valley since 1883. In 1883 ditches were comparatively small and those most easily constructed at that time. Those lands easiest to irrigate were first reclaimed. Structures were not expensive in the first construction. The Larimer and Weld and Greeley No. 2 Canals had been constructed at that time but had not been used to the extent that they are at present. They have both been enlarged and extended from time to time to a considerable extent. They were in operation at that time, however. Larimer County Canal was a small ditch at that time. It has since been extended to cover territory at present reclaimed. These three large canals cover more territory now than they did in 1883. Also carry more water. They have changed irrigation and crops.

Crops have changed from grain to production of which the land was largely devoted in 1883, to general farming, including sugar beets, potatoes, cabbage, onions, market gardening and fruit to a great extent. In earlier period nothing was talked about except grain farming.

During last fifteen years grain has been planted principally as a nurse crop for alfalfa and for preparation of soil to adapt it for cultivation of other crops. Alfalfa is almost universally planted with grain during first year. Alfalfa has brought our soil back to better condition than it was in its virgin state. During grain farming the lands ran down so that we had to put in alfalfa to bring about a better soil condition.

2459 Alfalfa itself is a profitable crop. It is a necessary crop in order that we may raise sugar beets, potatoes, and feed cattle and sheep. Feeding is one of principal industries in valley. In first year of feeding we obtain good grain crop and stand of alfalfa but not much crop of latter.

In 1883 irrigation development was nothing in valley as compared with present. Irrigation system has developed into entirely different proposition now from what it was then. At that time we simply had ditches taking water directly from river and when water came we would use it. Since then we have constructed reservoir systems and provided for times when there is no natural flow in stream. We have also extended larger canals so as to more than double area of land covered. The area is much more than doubled.

Reservoirs have been constructed, maintained and operated by farmers as a rule. The necessities of the valley forced the construction of the reservoirs. We found we were at the limit in raising grains and had to do something else. We had to provide water for later crops which were more profitable and keep the land in a higher state of fertility. Grain alone did not prove a profitable crop.

2460 The water commissioner is the official who has charge of the water exchange system in Cache la Poudre Valley. This exchange system more nearly resembles a banking system than anything else to which I can refer, with the water commissioner as the Clearing House. The occasion for the development of the exchange system in the Poudre Valley was occasioned as follows: In about 1888, we had reached a point where it was evident that some change was required. I was Water Commissioner. It was year of lowest water since 1874. Grain farming had demonstrated that it was going to become an absolute failure. Potatoes were coming to front as a very important crop and farmers were finding out they could raise alfalfa, fruit, vegetables and many other crops beside grain, and in which there was more profit. Under many of our ditches it was evident that it was useless to plant crops that would require late irrigation. Grain needed irrigation in June. Other crops required late water. Reservoirs were required for use in conjunction with natural flow of stream to enable irrigator to raise crops requiring late irrigation. A number of ditch companies found natural basins in which, by building dam on lower side, they could impound large quantities of water. These were constructed in many cases. They found many of these basins in such a position that they could fill from their ditches, but could not divert the water into their ditches again because their reservoir was lower than the ditches. The problem then was to get water below your ditch above the same ditch so that it would be available for diversion.

2461 To illustrate: About that time the North Poudre System had a number of basins that could be filled only by their own canal. The Larimer County ditch owners found a number of basins they could fill from their canal, and the Larimer and Weld Canal, the next large canal below the Larimer County, found a very large basin north of town of Windsor below their canal but above the Cache la Poudre Canal or Greeley No. 2. This was the Windsor Reservoir. A large reservoir was constructed on this site—the largest we have in the district. All of these reservoirs were filled during the winter season and during the flood periods.

Windsor Reservoir is lower than the Larimer and Weld Canal, but is filled by that canal and discharges its water directly into the Cache la Poudre Canal, commonly called Greeley No. 2 Ditch. The North Poudre Canal is the highest up stream. The next canal down stream was the Larimer County Ditch at that time. Since that time the Poudre Valley Canal has been constructed between the two. The next canal down stream was the Larimer and Weld Canal, commonly known as the Eaton Ditch. The next and lowest large canal on the north side of the stream is the Cache la Poudre Canal or Greeley No. 2 Ditch.

At the close of season of application of water by irrigation until the next season, all waters available in stream are stored in these reservoirs. The filling of these reservoirs is completed with the spring rise in the river. At that time we usually have a little surplus to finish filling the reservoirs.

The North Poudre Canal, which is the highest canal up-stream, is the canal having the last or poorest priority. It is the first ditch requiring water from its reservoir system. It so happens that the canal having the first priority, senior or better priority or claim to the waters of the river, is the Greeley No. 2 Canal, situated the lowest down the valley. It also happens that the claims for water between these two large canals becomes inferior as you go up the stream. Greeley No. 2 or Cache la Poudre is the senior, Larimer and Weld comes next above it, Larimer County is next in priority and is above the Larimer and Weld Canal on the stream, North Poudre Canal is fourth and above all three in priority and location.

Before the necessity of using reservoir water begins the Windsor Reservoir Company will hold a meeting and declare a dividend of water from the amount they have on hand, that is, they will decide what number of cubic feet they have available to be apportioned on each water right or share of stock in the company. The great majority of that water has to be used under the Larimer and Weld Canal which is located higher up stream and above the Windsor Reservoir. As soon as they declare the dividend, they will notify me that they require, say for example, 500,000,000 cubic feet of water transferred above the reservoir so it will be available at their ditch.

2463 They say, as soon as you can get water above us, get it, we will turn from Windsor Reservoir into Greeley No. 2 Canal any quantity you want when there is call for reservoir water above. Let us supply Greeley No. 2 Canal so we can get it later.

The Larimer and Weld Canal does not need to use reservoir water as early as does the North Poudre Canal and Larimer County Canal, because the river priorities of the latter are inferior to the former.

At the time of the beginning of the exchange, Greeley No. 2 Canal has a full supply of water in the stream. As soon as water begins to get scarce, the first canal to shut down will be the North Poudre, the highest canal up the stream and the junior appropriator. Instead of cutting off the water supply from their ditch as in former years, we don't do that at all. They, for example we will say, require 200 second feet of water. We don't disturb that at all. They continue to use it but turn out an equivalent from Windsor Reservoir into Greeley No. 2 Canal, for the reason that the shortage would occur at that canal as it is furthest down the stream. Instead of making up the shortage by shutting off the North Poudre Canal I leave whatever there is flow in that canal and turn the same amount out of Windsor Reservoir to make up the shortage in the river, but don't pay Windsor Reservoir Company any water yet. The equivalent of the water turned out of Windsor Reservoir is held back for the Larimer and Weld Canal by the North Poudre people in their reservoirs Nos. 5 and 6, or Fossil Creek Reservoir, or wherever it is most desirable to take it from as the season develops.

During perhaps the next week or two, the river will keep on dropping and Larimer County Canal will lose its right to divert water from the river and will be forced to draw upon its reservoir supply. We will suppose Greeley No. 2 Canal would still be entitled to 150 cubic feet of water per second after diverting 150 cubic feet per second into the North Poudre Canal. In such case we let the 150 cubic feet per second due to Greeley No. 2 Canal flow into the Larimer County Canal and turn an increased amount out of Windsor Reservoir to supply the shortage thus occasioned to Greeley No. 2 Canal. The Larimer and Weld Canal has not required the use of any reservoir water as yet, as they are still getting their river appropriations but by this process I am getting the water out of Windsor Reservoir and above the Larimer and Weld Canal and in the reservoirs of the North Poudre systems and the Larimer County System.

2464 Most of the owners of capital stock in the Windsor Reservoir Company draw their water through the Larimer and Weld Canal or Eaton Ditch which is located higher up the stream and above the Windsor Reservoir, but by this system I am getting the water represented by their stock up into the reservoirs belonging to the North Poudre Irrigation Company and The Water Supply and Storage Company, to the extent of from 250 to 280 cubic feet per second. Whenever the river supply for the Larimer and Weld Canal becomes insufficient, we pay back to that canal the water already taken from Windsor from reservoirs Long Pond, Rocky Ridge, Richards No. 2, 3 and 4 of the Water Supply and Storage Company's system. These all discharge into Larimer and Weld Canal and the North Poudre system pays for water it took out belonging to Greeley No. 2 by discharging the waters of Reservoirs No. 5 and 6 into Larimer County Canal, and the Larimer County Ditch pays what it owes by discharging, as I have said, from these four reservoirs into the Larimer and Weld or Eaton Ditch, until the bill is paid. If they draw more than they have advanced, they will balance accounts by discharging water from their reservoirs into Greeley No. 2 Canal, so that 100 cubic feet of water per second of time from Greeley No. 2 Canal river appropriation serves to exchange 100 cubic feet per second of reservoir water belonging to the North Fork System,

2465 100 cubic feet of water per second of time belonging to the Larimer County Ditch System, and 100 cubic feet of water per second of time belonging to the Windsor Reservoir Company.

This exchange system, in its final analysis simply amounts to taking out 100 cubic feet of water per second of time, for example, from Cache la Poudre River at head of North Poudre Canal instead of at the head of Greeley No. 2 Canal, and the running of that 100 cubic feet of water per second of time from head of North Poudre Canal to Greeley No. 2 Canal through a series of artificial canals made up of ditches and reservoirs, down through the various steps I have described, in lieu of letting the water pass down the river past those several headgates and to the headgates of Greeley No. 2 Canal. So that, while for all purposes Greeley No. 2 Canal is getting 100 cubic feeta of water per second of time on its so-called direct river appro-

priation, in fact it is getting water that was stored and diverted from the Poudre River many months previous.

The whole system of exchange simply amounts to compensation by one ditch company to another company for water taken and measured in quantity. The illustration I have given prevails throughout the Poudre Valley wherever it is possible. This system was brought about through the necessities of the case. Reservoir water was absolutely necessary.

2466 The exchange system has brought about such an economy in the use of water that we now have big sugar factories in operation, making sugar to their limit. Without the exchange system we could not raise beets enough to supply one factory. It has resulted in great economy in the use of water.

Rights to use of water from the Cache la Poudre River are represented by decrees issued by the District Court of Colorado—the Eighth Judicial District. When I speak of ditch or direct decrees, I refer to decrees authorizing the appropriation of water for irrigation for direct and immediate use from the stream to ditches and not for filling reservoirs. The reservoirs were constructed at a much later date. They have decrees authorizing diversion of water from the river on later priorities. We have separate decrees for reservoirs obtained in separate proceedings. The rights to divert water by reservoirs were adjudicated apart from those fixing the rights to divert water by ditches.

By the exchange system I am utilizing water obtained upon junior decrees to compensate for water taken from the river belonging to senior decrees. If we could not utilize and put into full force and effect this system of exchange on the Cache la Poudre river, it would have a very damaging influence and the water could not be made to do the same service as at present. A large amount of the water would be wasted and would pass down the river. We might compensate that to a certain extent by building ditches above, but it would result in heavy expense and we could not use the water as extensively as at present.

2467 Am familiar with Colorado statutes authorizing exchanges of water in manner I have described. I wrote the bill. The drafting of this bill and its enactment into law followed the actual practice of exchange of water in the Poudre Valley. When it was first initiated we had no law authorizing it. The practice was authorized by law four years subsequent to the initiation of this method of handling this problem. This has been the history of nearly all irrigation law of Colorado, from the earlier days down to the present time. The law has usually followed the practice. The settlers first constructed the canals, and irrigated and formed their rules which were later enacted into law.

The Cache la Poudre Valley was ahead of the rest of the state in development and demand for enactment of laws governing irrigation. It was the first district adjudicated in the state. The priorities date back to 1860 in some cases. The water rights were fixed by decree in 1882, although irrigation had been practiced since 1860.

2468 First water commissioner on Cache la Poudre River was appointed in 1879 or 1880, but was unable to perform any services except in advisory capacity until 1882, when decrees were entered. The enactment of law providing for water commissioners was brought about because of continuous increase in use of water to such an extent that it became very scarce. On lower portion of streams some irrigators had prior ditches to those canals above and it was found absolutely necessary to have some authority over the stream in order that the lower canals and older appropriators might get their water. Some regulation was necessary in order to do justice to early appropriators. In other words, the junior and inferior claimants were robbing the senior and superior claimants of their water supply. If no river commissioner had been appointed, there would have been considerable violence and a great deal of unnecessary trouble over water distribution. The man entitled to receive it would not get the water except by power of might and it was impossible to let the matter go in that way. It was necessary to have an adjudication. Even if regulated by litigation and enforcement of court decrees it would have entailed a great deal of expense and taken a long time and innumerable suits.

2469 Shortage or lack of water brought about the police regulation of streams in Colorado. This shortage first occurred in Cache la Poudre Valley. Up to the time of the beginning of the construction of larger ditches out of this valley, there was water enough for the smaller ditches on the river bottoms, and there was not much need for supervision until the construction of ditches for taking the water out onto the plains. The latter canals were large. The first ditches were constructed for the irrigation of river bottoms.

If it were the fact that no river commissioner were needed or called upon to make distribution of water from streams for a period of years, it would be indicative that there was water enough in the stream to supply those who needed; otherwise, there would be need for supervision. This lack of supervision would signify water supply more than sufficient to supply the demands; there would have to be a surplus of water. Supervision has been a necessity throughout the West, wherever there has not been a surplus of water. Irrigators diverting water from a stream without supervision are not inclined to take less water than they really need.

2470 About 305,000 or 310,000 acres of land are covered by ditches and irrigation works in the Cache la Poudre Valley outside of the acreage included within the Greeley Poudre Irrigation District. This acreage given would be subject to proper deduction for roads, reservoirs, and some large ditches, and some lands that lie higher than the canals; it is proper to describe them as sort of knobs. Small deductions should be made for various other reasons.

2471 In 1883, when I first became water commissioner, there was not more than one-half the acreage under irrigation that is reclaimed at present. Would think that there would be about half of the present irrigated area in 1890. Think the area has about doubled since 1890. Extension of irrigated area has been brought about from different causes. One important cause is construction of

reservoirs. Another is additional supply of water derived from other water sheds, such as Laramie, Grand and Michigan Rivers. Another very important cause is knowledge gained by irrigators as to best methods of applying water and economy in its use, curtailment of waste which used to exist under old methods, etc. We can make water irrigate more land than we used to. All three of these I have mentioned are factors in extending the area of reclaimed land.

It has been my custom and the custom of the other officials in Poudre Valley to prevent waste wherever possible. When we find appropriators wasting water we cut off supply to extent we believe they are making wasteful use. We keep supply shut off until we are satisfied they really need an increased supply or take pains to put it to better use than they did before.

2472 These various reservoirs belonging to different owners in valley are frequently used under my direction for impounding waters other than those to which such reservoirs are entitled from their decrees. It so happens that in some cases our old reservoirs are located lower down the stream than our later reservoirs. It is our aim, as nearly as possible, to fill upper reservoirs even though they are junior to later reservoirs, still guaranteeing a full quota to those reservoirs. We have more water available lower down than higher up stream and sometimes if we supplied appropriations in usual order of priorities, after we fill lower senior reserviors we would have plenty of water below which would go to waste after such reservoirs were filled. So that, in so far as we can, we fill upper reservoirs first, even though junior in priority, and guarantee to lower reservoirs that if they are not filled they will have their quota from upper reservoirs. We generally get the owners of the reservoirs together upon a proposition and have an understanding with owner of upper reservoir that he is taking the water out of his turn on condition that senior reservoir below must be supplied, and if it turns out later that we do not have enough available water below, it is recognized that the lower reservoirs' water is in the upper reservoirs, and that the seniors must have it and, being in reservoirs above, it is easy to turn it down. If the water were in the reservoirs lower down it would not be possible to get it into the upper reservoirs. There is no statute permitting this, but we have been doing these things by amicable agreement, regardless of want of authority by statute. It all works for economy of water. This practice

2473 has been recommended by State Engineers. The present State Engineer, Mr. Field, has recommended that I do it wherever possible. Mr. Comstock, his predecessor, also recommended it.

When exchanging water, I credit the senior reservoir with the amount of water in the higher or junior reservoir and notify the senior reservoir that there is water in the junior reservoir subject to the demand of the senior, and that they may draw upon it whenever they desire. At the close of the period of storage, we have a reckoning and notify the lower and senior reservoirs of the amount of water belonging to them and on storage in the upper and junior reservoirs.

It also sometimes happens that some system, such as, for example, The Water Supply and Storage Company might have water coming from a foreign watershed which they do not need at the time of its diversion, and which would be stored in the reservoirs of some other company by consent and on payment of a toll charge.

2474 This water is later withdrawn by the owner and applied in the irrigation of lands. Outside of such cases the storage of water in upper and junior reservoirs, which in fact belongs to lower and senior reservoirs, is a gratuitous service.

All reservoirs of valley are not only under my supervision as police officer, but are also placed at my disposal for use of empty space as my best judgment may dictate throughout season.

I keep in touch with various headgates and diversion works on river and outlet works at numerous reservoirs by telephone. Communication is had daily and sometimes several times a day, and I make it my business to visit all of them I can in valley as frequently as possible. Every part of diversion system of Poudre Valley, including outlets of reservoirs, is in constant touch with my office.

My office is a clearing house for the water system of the Cache la Poudre Valley. I keep a debit and credit account of exchange system. One reservoir may be out, for illustration, 2,000,000 cubic feet of water before they ever get a drop back, and I have to keep an account of this. They draw the water when they can make the best use of it. They put off demanding the reservoir waters as long as they can and hold this water as a reserve as long as possible and only use it when required to do so for growing of crops. Necessity alone prompts its withdrawal from reservoirs.

2475 Reservoirs are also used through exchange system for fragmentary runs of water that otherwise would be lost in the ditches. For illustration, instead of giving a ditch 30 feet for half a day or 60 feet for half a day, according to fluctuation of the stream, we might let them go without any water for a week and then turn out 100 to 150 cubic feet per second until their credit in the reservoir is exhausted, thus making it worth something to them, while if run directly from the river the water would be wasted in the canal. By this method of diverting these fragments of flow into a common receptacle and thereby accumulating them, we tend to greater economy.

From the standpoint of economy and efficiency in use and service of water, there is no comparison between the method of diversion and application of water directly from the stream and the diversion of water from the stream and storage in reservoirs for later application. The reservoir method of diversion, storage and distribution is by far the more economical. By the reservoir method, an acre foot of water brought to the land through process of diversion, storage and distribution, will do greater service and perform greater

2476 duty in irrigation of lands than an acre foot of water turned directly from the stream to the land. If you own 1,000 acre feet of water in a reservoir and your river supply is cut off, you will be just as economical with that water as you would be with your bank account. The water in your reservoir is your reserve and you

will be as economical as possible and apply it only when you need it. You can even shut it off at night and use it only in the daytime. But you must use river water when it is at your headgate. In other words, the only time you can use water diverted directly from stream, is when water is at headgate of ditch. The moment it passes your headgate it is beyond your control. The tendency follows to take all you can, when you can. You will draw it and may even let it pass out through the ditch, without use; but you would not do that with the reservoir; you would shut it off. It
2478 has been the experience that ditches will divert and water will be applied to lands already wet with heavy rains or from other cause, simply in order to avoid shortage later. This was experience before reservoir system was started.

Delivery of water from reservoirs of Cache la Poudre Valley is regulated to consumers upon order. Consumer will place his order with secretary of company, one or two days previous to time he will need water, and secretary each day totals up how many shares are ordered for carriage from reservoir and notifies superintendent, giving him list of stockholders drawing water for the following day. Superintendent knows night before how many shares are ordered of reservoir water for following day. He has proper amount turned into his ditch for delivery on the next day for those who have ordered water. This water is ordered according to rules fixed by company and a certain amount is required to be ordered to avoid waste. They could not run small quantities economically. They require a minimum amount of water to be ordered before a run will be made.

Each share at beginning of delivery represents so many cubic
2479 feet in reservoir. They generally run on basis of one cubic foot of water per second of time. Sometimes they will run less, depending upon conditions. A share, however, represents so many cubic feet of water in reservoir. In delivery it represents certain flow of water measured in cubic feet or fractions of cubic feet per second. They figure they have a cubic foot of water coming for so many days during season. An irrigator divides that up in time so as to irrigate his crops to what he considers best advantage. He may draw a few days now and then lay off a week, and then draw three or four days at a time. Irrigators have different ideas and each one decides for himself how he will draw his water.

One million cubic feet of water in a reservoir is equal to between 22 and 23 acre feet. A cubic foot per second of time of water running for 24 hours will deliver about 2 acre feet; that is, will deliver enough water to cover 2 acres a foot deep. There are about 11½ days constant run of a cubic foot of water per second of time for each million cubic feet of water in the reservoir. That is the usual way of estimating and delivering the water. This water is ordered and delivered to the farmers in the quantity desired in every in-
2480 stance, subject to the rule of minimum quantities in canals.

A water right in reservoir simply refers to the established unit among water users. It varies on different water systems. The Windsor system has 4 shares of stock which is termed a right of reservoir water by the farmers who own the reservoir. Other reservoir com-

panies have rights made up of varying number of shares of stock. These matters are not in my supervision. Superintendent tells me what he wants in cubic feet, and if he has it in reservoirs above, he obtains what he ordered.

Outlet gates of all reservoirs are regulated on my order. Keeper of outlet gates is employe of company owning reservoir, but takes his orders through my office. Could not make orderly distribution of water if did not have this method of discharging water from reservoirs.

2481 Economy in use of water requires the fixing of minimum amount of water that will be run in canal at any one time. If each irrigator under canal were allowed to draw his water independently of anyone else, you can see that in a long ditch the small quantity of water to which individual consumers would be entitled would be lost if run alone. You have to accumulate a large enough head so that you can deliver without unreasonable loss. There is bound to be a loss in any case. We always have to turn out more water than we can deliver to stockholders in order to make up for shrinkage in delivery, but we want to cut that loss down to the minimum. The stockholders have to stand the loss occurring between reservoir and their lateral headgate. The old canals are used as conveyers or carriers for the water stored in reservoirs. These canals are compensated for carriage in different ways. In case of Greeley No. 2 Canal a charge for carriage of reservoir water is made to stock holders. The reservoirs owners have shares also in the ditch company, but they are two separate corporations and they sometimes have different sources of reservoir supply. Some stockholders in Greeley No. 2 Canal have water rights in Windsor Reservoir and some in the Timnath Reservoir, and the company charges for carriage of reservoir by the quantity conveyed.

Farmers, even in management of their laterals, make a custom to run water together, so as to carry as large a head as possible. Even between individual farms in distribution, it is custom, when head is small, to exchange between one another, that is, one may will to take his own water and that of two or three neighbors for a certain number of hours and then the other man will take the whole head, etc.

2482 Custom is to give such crops as beets, potatoes, cabbage, onions, peas, beans, and like highly cultivated crops, light but frequent irrigations. The irrigators stay with the water every moment of their time, day and night.

Loss of water for running in canals is occasioned by evaporation and seepage. The larger the head the less the ratio of loss.

Water flowing from the Cache la Poudre River at mouth of cañon is divided from day to day by system of gauges up and down river at important canals. We have rating station in cañon itself gauges at convenient places down the rivers. Have reports from all those ditches every morning and evening and sometimes every noon, showing amount of fluctuation. Large ditches all keep headgate man all through season, day and night. I get reports from them as fre-

quently as I wish. I always demand a report the first thing in
2483 morning, which is usual time of rise of water in river. At headgate of Larimer County Canal the rise comes very early in morning, reaching other stations as they go down stream. I begin calling headgate men from 4:30 A. M to 5 A. M. Continue calling from two to three hours.

In early part of season, when we have a high river, fluctuations during day are as much as 500 second feet between the high and low water marks. High water comes in early morning and low water comes in afternoon. If Larimer County Ditch, for instance, is entitled to its full appropriation at high waters, I give headgate keeper a mark below his headgate which is sufficient to supply prior appropriators below, and I order him to keep the river up to that mark, whatever it may be, knowing that is just what I need to supply prior appropriators below. As ditch reaches point where he has only water he is entitled to, that is, water from the Laramie, Grand and Michigan and appropriations from river, he shuts headgate down to that point. If water goes below mark on gauge in river, he notifies me he cannot keep river up. Then I come to next junior, which would be Larimer and Weld, and give him an appropriate order. This may require him to cut out 50 or 100 cubic feet per second out of canal, but it does not make any difference, he keeps up the amount for prior appropriators below. In afternoon, when flow has reached its minimum, I know next change will be a rise, and at night I tell man at Larimer County headgate that when river comes back to certain point he may take water. As river rises, he takes rise into canal. The same is true with Larimer and Weld Canal. If latter canal is cut out during afternoon, when river is up in the morning he takes on water just so he allows required amount to pass. That is the way the ditches are regulated. With little ditches I sometimes go and shut headgates myself or order superintendent to do so.

I do not use deputies in distribution. Only ones I use are to keep track of water coming from other water sheds, which is quite a way off from my point of observation. I attend to distribution alone. I could not do this work alone without aid of telephone.

First telephone lines in valley were private phones built by ditch companies for use of river commissioner and company employes.
2485 These phones have been done away with. They were used until we could do better. When the general telephone system became installed through country, we found it more handy to use it. Both ditch companies and water users used the general telephone. Installation of telephone in first instance was required for communication between me and ditch people. It would be impossible to make distribution under the very complicated and elaborate system prevailing in Cache la Poudre Valley without these various headgate and reservoir men at their stations day and night.

The gauges at fixed canal headgates of which I spoke, are located just below the dams of these headgates. They are used to keep account of water passing. Principal rating station is at mouth
2486 of cañon, a little above the mouth.

I have kept general account of amount of water passing

out of Cache la Poudre Valley at its mouth and entering South Platte River. I have been required to report on that the same as I report on amount of water that goes into ditches. My duties are performed in connection with duties of other water commissioners, and state officials require knowledge of amount of water going into other districts as well as into mine. I am only one spoke in the wheel, and in order to make proper distribution in districts below me, Division Engineer and State Engineer have to know the amount of water flowing into that district from various sources.

Am compelled to report amount of water going out of Poudre River into South Platte River on account of ditches taking water from South Platte River below mouth of Poudre. It assists man below to distribute. He must know how much he has to distribute. There are many ditches taking out of south of Platte River below Poudre. There are some very large ones. This is true throughout the river to the interstate line.

2487 The water flow discharging from mouth of Poudre for a large part of time is mostly seepage water. At times there is flow greatly in excess of seepage water, due to large amount of snow melting in June and July and to rains. These are flood waters that have passed diversions on Poudre. The passing of this water does not signify that every ditch on Poudre is necessarily diverting its full head of water. It sometimes happens that water is needed badly, but we have to run the water down into the Platte because of broken ditches.

Excess of water, over and above that coming from seepage and percolation, passing out of mouth of Poudre River occurs during month of June particularly, it may happen in latter part of May and early part of July. Have kept a memorandum showing general idea of amount of water discharged from Poudre River over a number of years.

(COPY OF DEFENDANTS' EXHIBIT 113.)

Water Flowing from Poudre to Platte River.

1909.		1910.		1911.		1912.		1913.	
Jan. 2	110	Jan. 1	180	Jan. 7	60	Jan. 6	85	Jan. 4	170
" 9	160	" 8	180	" 14	60	" 13	85	" 11	168
" 16	150	" 15	175	" 21	60	" 20	80	" 18	164
" 23	170	" 22	165	" 28	60	" 27	75	" 25	165
" 30	160	" 29	160	Feb. 4	60	Feb. 3	75	Feb. 1	125
Feb. 6	160	Feb. 5	155	" 11	60	" 10	75	" 8	125
" 13	160	" 12	160	" 18	60	" 17	75	" 15	135
" 20	150	" 19	160	" 25	60	" 24	75	" 22	128
" 27	170	" 26	160	Mar. 4	60	Mar. 2	75	Mar. 1	140
Mar. 6	160	Mar. 5	160	" 11	60	" 9	75	" 8	100
" 13	160	" 12	120	" 18	60	" 16	85	" 15	97
" 20	160	" 19	110	" 25	60	" 23	80	" 22	100
" 27	180	" 26	90	Apr. 1	60	" 30	80	" 29	100
Apr. 3	240	Apr. 2	90	" 8	45	Apr. 6	80	Apr. 5	105
" 10	170	" 9	100	" 15	45	" 13	80	" 12	144
" 17	180	" 16	80	" 22	45	" 20	80	" 19	110
" 24	200	" 23	60	" 29	45	" 27	90	" 26	160
May 1	200	" 30	60	May 6	45	May 4	70	May 3	140
" 8	100	May 7	70	" 13	45	" 11	130	" 10	80
" 15	85	" 14	75	" 20	45	" 18	200	" 17	270
" 22	160	" 21	200	" 27	45	" 25	80	" 24	80
" 29	185	" 28	70	June 2	45	June 1	100	" 31	707
June 6	1608	June 4	70	" 10	45	" 8	700	June 7	50
" 12	2700	" 11	40	" 17	45	" 15	200	" 14	55
" 19	4500	" 18	40	" 24	45	" 22	150	" 21	55
" 26	2720	" 25	40	July 1	45	" 29	220	" 28	50
July 3	2000	July 2	40	" 8	60	July 6	200	July 5	50
" 10	885	" 9	30	" 15	50	" 13	75	" 12	40
" 17	40	" 16	30	" 22	50	" 20	70	" 19	40
" 24	60	" 23	30	" 29	50	" 27	250	" 26	120
" 31	60	" 30	30	Aug. 5	50	Aug. 3	200	Aug. 2	50

Aug. 7	60	Aug. 6	30	" 12	50	" 10	70	" 9	50
" 14	60	" 13	30	" 19	50	" 17	70	" 16	40
" 21	60	" 20	30	" 26	50	" 24	70	" 23	40
" 28	60	" 27	30	Sept. 2	40	" 31	70	" 30	40
Sept. 4	60	Sept. 3	30	" 9	40	Sept. 7	70	Sept. 6	40
" 11	100	" 10	30	" 16	40	" 14	100	" 13	60
" 18	130	" 17	30	" 23	40	" 21	180	" 20	90
" 25	150	" 24	45	" 30	40	" 28	110	" 27	150
Oct. 2	120	Oct. 1	30	Oct. 7	40	Oct. 5	115	Oct. 4	264
" 9	110	" 8	50	" 14	70	" 12	115	" 11	90
" 16	130	" 15	80	" 21	40	" 19	125	" 18	120
" 23	130	" 22	85	" 28	70	" 26	140	" 25	120
" 30	130	" 29	105	Nov. 4	60	Nov. 2	135	Nov. 1	120
Nov. 6	130	Nov. 5	125	" 11	90	" 9	130	" 8	120
" 13	130	" 12	125	" 18	90	" 16	160	" 15	120
" 20	140	" 19	102	" 25	90	" 23	160	" 22	110
" 27	200	" 26	50	Dec. 2	90	" 30	170	" 29	110
Dec 4	190	Dec. 3	50	" 9	90	Dec. 7	130	Dec. 6	120
" 11	210	" 10	55	" 16	90	" 14	170	" 13	120
" 18	210	" 17	60	" 23	90	" 21	170	" 20	120
Dec. 25	190	" 24	60	" 30	85	" 28	170	" 27	110
Total in acre feet for year	288,558		60563		41236		91983		85942

Defendants' Exhibit 113 is a statement showing amount of water flowing from Cache la Poudre River into South Platte River during years of 1909, 1910, 1911, 1912 and 1913. Table was compiled from weekly reports of water commissioner of District No. 3 to State Engineer. It is made up from my own reports. I stated there is constant flow from mouth of Cache la Poudre River, occurring from seepage and percolation. Referring to Exhibit 113, will state that in year 1911 there was no flow of water from mouth of Cache la Poudre into South Platte River other than that occasioned by seepage and return waters. Amounts given in column for 1911 on Exhibit 113 indicate the amount of seepage and return flow escaping from river during that year.

In year 1909 there was very large excess of water, over and above seepage and return water, passing down into South Platte River. It is year of largest excess flow shown on this sheet. There was also some in 1912 and in 1913 and probably a little in 1910.

Have calculated amount of discharge of water from mouth of river during 1911, that being year when no other than waters coming from seepage and return escaped at that time. Amount is approximately 41,236 acre feet.

I calculated amount of water passing from mouth of river in 1909, being year of largest flow. The flow thus obtained includes the flow from seepage and return water as well as from flood water. Aggregate amount escaping in 1909 was 288,558 acre feet.

Years 1909 and 1911 respectively represent the high and low years in the history of the flow of the stream during my administration.

2488 In 1911 we had no more water than was necessary to supply demand on streams by ditches, and in fact did not have enough. There was general shortage of water in 1911, also in 1910. Think we had more water in 1911 than in 1910, but 1910 followed big year of 1909, continued to deliver more return water in proportion to amount coming through cañon than in 1911, because 1911 followed low year 1910.

Have calculated amounts of discharge of water from all sources, both seepage, return and flood, during 1910, in acre feet. Total amount was 60,563 acre feet.

Have calculated amount of such flow for 1912. It amounts to 91,983 acre feet.

Of the 5 years that I have given on this table, 1911 carried the least water into the South Platte River. The discharge of 41,236 acre feet for that year, may be taken as low discharge for seepage and return water into South Platte River from Poudre.

2490 The Ogilvie Canal diverts water from Cache la Poudre River and receives its supply almost altogether from seepage and return water. It is situate about 4 miles above the mouth of the Poudre. They have a reservoir, Seeley Lake, filled by Greeley No. 2 Canal. This reservoir receives its supply from seepage water. Greeley Colony Canal No. 3 receives a large portion of its water from seepage and return water. Boyd and Freeman Ditch also receives principal supply from same source and same is true of Wm.

R. Jones and B. H. Eaton Ditches. This Eaton ditch is not the large canal of the Larimer and Weld Irrigation Company sometimes called Eaton Ditch. The B. H. Eaton ditch is a small ditch that heads on South Side of river southwest of Windsor.

Whitney Ditch obtains large portion of its supply from seepage and return water, and same is true in small measure of Greeley No. 2 Canal and Box Elder Canal.

2491 At times we are required to let more than the seepage water go by the headgate of Greeley No. 2 Canal in order to supply older priorities below. At times there is not enough seepage water to supply them and at other times there is. This varies with conditions.

There is some seepage and return water intercepted by ditches themselves. This is true of all canals below the upper one. These canals also intercept rain water that otherwise would go into river.

Seepage water appears at various places under larger canals, in low lying lands and draws. This water is generally used for irrigation and it is the custom to use all of it.

Amount of water which I have given as flowing from mouth of Cache la Poudre River into South Platte River in the year 1911, represents the net amount of return and seepage water left or remaining after all uses and re-uses of the return and seepage water has occurred in Cache la Poudre Valley.

Defendants' Exhibit 113, a tabulation, offered in evidence.

There was greater flow of return and seepage water in year 1910 than in 1911, on account of fact that 1910 followed year 1909, which was year of high flow. That is general experience in Cache la Poudre Valley. In year of high flow, everybody has all water they need, all reservoirs are filled, and land is thoroughly irrigated. This causes continual discharge of return water during next season.

Irrigation systems, such as that of Greeley-Poudre Irrigation District, with its works located as they are, would not get any benefit of water discharged from Cache la Poudre River at its mouth and coming into that stream from sources of seepage and return. Of all the water which is discharged from mouth of Poudre, only part upon which this system could depend for its supply, would be that portion in excess of amount required by prior appropriators, coming from cañon mouth. No waters coming from cañon mouth are considered seepage and return waters. This is called original water.

2493 The irrigation system of the Greeley-Poudre Irrigation District would be compelled to depend upon surplus of that class of water as its only source of supply from the Cache la Poudre River. I refer to surplus over and above amounts necessary to supply needs of prior appropriators.

Under term "prior appropriators" I include all prior approriators on South Platte as well as Poudre River. All water of Poudre river is just as much subject to demand by appropriators on South Platte as it is with those on Poudre River in the order of priority.

Decree of water right on Cache la Poudre River or any other stream, does not amount to guarantee that the owner will receive amount of water specified in decree, unless it is among the very earliest priorities. It is a pretty good guarantee if the priority is early enough, but it would have to be pretty early. The decree merely represents that if there is enough water to supply all appropriators, then you can have the next turn at the water to the amount of your decree. Even then you would not be entitled to that water if you did not have actual need for it. This is implied or expressed in the decree itself. Each of these decrees carry prohibition against waste and excessive use.

Residue of flood water to which Greeley-Poudre System would be entitled from Poudre River after all prior appropriators on both Poudre and South Platte have been satisfied, would not be sufficient in the aggregate to warrant construction of any expensive works for its utilization. That is, this supply of water taken alone would
2494 not warrant such construction. To warrant expenditure of required amount of money necessary to obtain use of these excess flows of Cache la Poudre River, it would be necessary to supplement that supply by construction of reservoirs and diversion of water from other water sheds, where it is available.

Laramie River system of Greeley-Poudre Irrigation district, consisting of tunnel and diversion ditches, would constitute valuable source of supply, or at least a partial supply which, augmented by system of reservoirs for impounding water when not immediately needed and which added to amounts they could get periodically from Poudre River, would probably constitute sufficient supply to warrant the outlay necessary for construction of the elaborate system of works contemplated.

Defendants' Exhibit 113 represents fluctuations which may be reasonably expected on Poudre River.

I remember when Sky Line Ditch, Grand River Ditch, Michigan Ditch, Laramie Lake, and Lost Lake Reservoirs of Water Supply and Storage Company were constructed. Reason for construction was that appropriations to Laramer County Canal from Cache la Poudre River were not sufficient to irrigate the lands intended to be reclaimed by that canal. The appropriations from Poudre River were woefully insufficient. In fact it was seen the canal was going to be a failure, if dependence were placed on Poudre River
2495 alone with the prior appropriations that existed. Construction of those inter-watershed division systems made just the difference between bankruptcy and prosperity for the territory lying along and irrigated from Larimer County Canal. It gave them a tangible water supply to depend upon. They knew no matter how low the Poudre got that they had some water coming, and no matter how curtailed the amount, they had some water by which they could raise crops. They had a steady stream from Grand and Laramie Rivers and they could get some water for their grain and alfalfa, but for their growed crops, the crops in which there was

money, they could not depend upon getting any water from the Poudre River at all.

Irrigation farming requires crop yielding good, heavy return in money. This is especially true where they have to go to expense that Water Supply and Storage Company did to obtain water and to keep up the system. Returns from construction of Sky Line Ditch and other inter-watershed ditches of Larimer County Ditch system justified the expenditure. Since completion of these inter-watershed ditches, they have raised good crops under the Larimer County Canal, and not only that, but they have extended their irrigation area largely since they acquired these additional
2496 waters. Generally speaking, crops are as good under that canal as they are under either the Eaton Ditch or the Greeley No. 2 canal, which hold earlier priorities.

During year 1913 crops under Larimer County Canal and irrigated by it, compared very favorably with the crops raised under that canal for the last ten or fifteen years, in fact, they raised more crops in 1913 than they did ten or fifteen years previous. A larger acreage. The production would represent pretty fair average with other years, except with potatoes. In last two or three years, potato blight has bothered the crop, regardless of water supply. Crop was better in 1913 than in 1912. Potato crop in 1913 was not as good by any means under any canal as it was in 1909 or 1910.

Other than for potato crop, crops under Larimer County Canal in 1913 would be better than in previous years. There was a larger acreage covered and their water system is getting down to better and steadier basis every year. Management is improving with experience and they know better how and when to apply water
2497 than they used to. Greater economy of water is promoted by better cultivation and more skill in cultivation and irrigation.

Irrigation over long period of years diminishes amount of water required. Land does not require more than one-half the water, after period of years as in the first instance.

There are additional unreclaimed lands which may be reclaimed and irrigated by extensions of all the several large canals in the Cache la Poudre River. There are possibly hundreds of thousands of acres that may be so reclaimed. These canals will be able, if it should in the future prove that they have more water than they need for the present acreage, to extend their lines and take in additional acreage.

Older canals on Poudre River are senior to the Greeley-Poudre System with diversion from Poudre River. Their claim would be preferred to that of the Greeley-Poudre System. In the
2498 matter of extension of areas, they would naturally have preference in so far as their decrees permitted. The decrees of these older canals are not limited to any amount of acreage.

Extension of acreage irrigated occurring from better and more economical use of water under old canals is gradual. A little added from year to year. It requires continuation over quite a period of years to bring about any considerable expansion.

About 55,000 acre feet of water are discharged on average each year at mouth of Poudre River, coming entirely from seepage and return waters. That is net discharge after all ditches have taken all they can from Poudre River.

2499 JOHN L. ARMSTRONG.

Cross-examination by Mr. N. E. Corthell:

There are about 305,000 to 310,000 acres of land under irrigation in Poudre Valley, including highways and some high lands. Some parts of each 160 are not irrigated, of course. In my official reports, I stated there were 220,000 acres irrigated in 1911 and 240,000 acres in 1912, but I want to explain that when I made that compilation it was required to report number of acres of alfalfa, cereals and beets and did not include anything except actual acreage in crop. The area I have just given includes the irrigated area,
which would be quite different.

2500 My estimate of the acreage actually irrigated in the Poudre Valley would be from 240,000 to 250,000 acres. This includes no lands within the Greeley-Poudre Irrigation District and if any lands are irrigated in that district, I have not included them in my report. I included nearly all of the lands that are actually watered, but there are some little mountain ditches and some seepage irrigation that I do not report. I have not included quite all the smaller ditches. From memory, I should say that in 1890 only about one-half this area was irrigated. In 1883 I would estimate that there were not more than 100,000 acres irrigated and possibly not that much.

The present system of control which I use is to utilize the employes of the various ditch companies. I telephone my orders to
them in the mornings and evenings, and the greater part of
2501 the day I devote to visiting various headgates and to ascertaining that my orders are being followed.

The construction of reservoirs in the Poudre Valley was largely the result of the very dry year of 1888, but the construction of large
reservoirs did not commence for a couple of years, until about
2502 1890. Aside from several basins used by individual irrigators to store their ditch water at night, there are perhaps seventy or a little more reservoirs in the valley, running from those with a capacity of about 1,000,000 cubic feet to 18,600 acre feet. The average would be about 100,000,000 cubic feet or 2,300 acre feet. I do not know how much land is covered by these reservoirs. The depth varies from 5 to 70 feet, and the average depth of these reservoirs would be, I would estimate, between 25 and 30 feet. The largest reservoir, the Windsor, is only 37½ feet deep, whereas the Halligan Reservoir, with about one-third of the capacity, is 70 feet
deep.

2503 Most of the reservoirs in the Poudre Valley are located on the plains. The large ones run from 30 to 38 feet in depth. The small ones are less in depth. There is a loss in transit in handling water from reservoirs through the ditches to the consumers.

The seepage from storage of water is not always a loss. It would only be a loss to the lower reservoirs. Evaporation is a loss under any condition. The seepage loss is not very great in the valley reservoirs. The seepage is captured by the ditches below. The seepage water that goes down the Poudre and appears on the low land accounts, to a great extent, for the water that seeps out of the Poudre into the South Platte.

The figures of run-off from mouth of Poudre at intervals of one week for four years were obtained by my knowledge of the
2504 amount of water that would go in if there was any surplus. There have been frequent measurements on the river at the lower end by deputy state engineers and the government station at Fort Collins, and I was always furnished with these figures. I would know what would be going if the Ogilvy ditch and No. 3 Ditch were drawing, and at times measurements were made when these ditches were not drawing. I would know what was going through and the amount of the surplus going by Greeley No. 3. The figures I give are not from gauge records kept at mouth of Poudre, but Professor Carpenter made a series of measurements at the same time and during the years I made these figures, and actual measurements made by Professor Carpenter and figures I furnished tallied so closely that it was surprising. My knowledge of amount of water flowing in the stream up above was obtained from gaugings and my estimates were based upon my knowledge of previous measurements and by applying my observation to the condition of flow of the stream, coupled with experience in handling water in the stream. You might call them estimates. The measurements were not made on the day I reported them, but they were actual measurements made on days preceding them. I do not now have
2505 my estimates for any year prior to 1909, but I recall in a general way that the flow from the oPudre into the South Platte was formerly less than at the present time. Average run-off based upon such estimates over a period of five years and due only to return flow and seepage and exclusion of surplus flood waters would be 55,000 acre feet. The total flow from the Poudre into the Platte in 1913 I estimate to be 85,942 acre feet, and the total run-off at the mouth of the Poudre for the last five years would be approximately 113,000 acre feet per annum, but this is abnormal because the year 1909 had a very excessive run-off so that I would say that the average run-off over a longer period would be about 90,000 acre feet.

2506 Direct examination, continued, by Mr. Delph E. Carpenter:

I calculated amount of discharge of water from Poudre River in acre feet during year 1913. Amount was 85,942 acre feet. That included all water that passed out of Cache la Poudre River into South Platte, including seepage, return, flood waters, and the waters from every source.

Cross-examination by Mr. N. E. Corthell:

2507 I believe that the run-off at the mouth of the Poudre for the years 1912 and 1913 would give an average close to the general average for a longer period. Of the 90,000 acre feet flowing from the Poudre into the Platte I would say that 55,000 acre feet consists of return flow and seepage water, and 35,000 acre feet is direct flow. A record has been kept of actual measurements of the flow of the Poudre at its mouth, but I do not have it. Many years ago I had supervision of these measurements but not in late years.

2508 The reservoirs in the Poudre Valley in the bed of the stream are the Halligan Reservoir on the north fork, with a capacity of 6,440 acre feet, Chambers Lake, near the head of the Poudre, with a capacity of 6,670 acre feet, the Cameron Pass Reservoir above Chambers Lake with a capacity of 805 acre feet, Sheep Creek Reservoir on Sheep Creek, with a capacity of 160 acre feet, Zimmerman Reservoir with a capacity of 115 acre feet, Fossil Creek Reservoir on Fossil Creek with a capacity of 11,730 acre feet, which has a natural stream running into it and which is also supplied by a ditch from the main river and by a number of

2509 canals, and Douglas Reservoir, which has a small creek running into it and which has a capacity of 8,000 acre feet, being filled chiefly by a ditch from the Poudre River. The Worster Reservoir is filled from an inlet ditch, and sometimes water is conducted into both Chambers Lake and the Cameron Pass Reservoir from other streams.

2510 There is no time of the year in which it is impossible to store the water of the Poudre in the reservoirs in the valley, excepting that there are two mills at Fort Collins which have to be supplied with water power, and there are only two reservoirs below these mills in which water can be stored, and when these two reservoirs are filled the water which runs past the mills cannot be stored. When the mills are running we have to furnish 60 second feet of water for about eleven hours a day. This year from about

2511 the middle of February until the water is used for direct irrigation the amount of water flowing past the mills will go down to the South Platte. Our winter flow this year has been greater than usual, so we have been filling the reservoirs more rapidly. Any average year the mill water which is not stored runs to the South Platte but a very short time; a month might be the average. These two lower reservoirs are Fossil Creek Reservoir, with a capacity of 11,730 and the Cache la Poudre with a capacity of 9,545 acre feet, and besides the water running past the mill there are

2512 accretions of perhaps 20 second feet to the river above the points of diversion for the reservoirs. More than half of the water that is stored in Fossil Creek Reservoir is taken from the Poudre River.

When the Larimer County Canal was started it was proposed to have some storage reservoirs, but none of them were constructed to start with, and the only storage capacity which the system had was the small amount already found in Chambers Lake, which had been

made into a reservoir for tie purposes. There was surplus water in the Poudre River at that time, and for a short period
2513 this surplus would be large, but it was beyond the financial means of the Company to construct reservoirs, which could hold this surplus water and it was a great deal cheaper to get water from the Laramie River through the Skyline Canal than to build channel reservoirs such as are now proposed by the Greeley-Poudre District. Although the original cost of channel dams may be
2514 great, channel reservoirs when constructed are more efficient and economical than reservoirs away from a stream. Large reservoirs are also more efficient than small ones.

My principal duty is to superintend diversions from the stream and from the reservoirs, and I do not give particular attention to investigation of the use of the water unless someone brings to my notice some instance of waste.

2515 Cross-examination by Mr. John D. Clark:

The statements relative to the use of water in my district contained in the annual reports of the State Engineer come from my annual reports. It was my practice to make annual reports covering the amount of water used through the various ditches and the number of acres irrigated, and these reports have been summarized, classified and printed in the annual report of the State Engineer. I do not recall the contents of my report on these matters, but I assume that my reports are the basis for the State Engineer's reports showing the amount of water used through the various ditches in District No. 3 in 1909 and 1910 as follows: Dry Creek Ditch in 1909, 3.78 acre feet per acre, in 1910, 2.94 acre feet per acre; Boyd and Freeman Ditch, 1909, .87 acre feet per acre; in 1910, 2.09 acre feet per acre; Whitney Ditch, 1909, 2.2 acre feet per acre; in 1910, 1.75 acre feet per acre; the B. H. Eaton Ditch, 1909, 1.12 acre feet per acre; in 1910, 2.23 acre feet per acre; John Ames 1909, 2.62 acre feet per acre; in 1910, 1.07 acre feet per acre; Cache la Poudre Irrigation Ditch, 1909, 3.12 acre feet per acre; in 1910, 3.41 acre feet per acre; New Mercer Ditch, 1909, 2.08
2516 acre feet per acre; in 1910, .59 acre feet per acre; Canal No. 3, 1909, 3.47 acre feet per acre; in 1910, 3.37 acre feet per acre; Cache la Poudre Irrigation Company Ditch, 1909, 2.12 acre feet per acre; in 1910, 1.16 acre feet per acre; Larimer County Ditch, 1909, 2.62 acre feet per acre; in 1910, 1.07 acre feet per acre; Pleasant Valley Ditch, 1910, 2.03 acre feet per acre; Larimer and Weld Ditch, 1910, .97 acre feet per acre; J. G. Coy Ditch, 1910, 7.94 acre feet per acre; Box Elder Ditch, 1910, 2.5 acre feet per acre; Bristol Ditches Nos. 1 and 2, 1909, 1.64 acre feet per acre; Fort Collins Canal, 1910, 1.03 acre feet per acre; Lake Canal, 1910, .91 acre feet per acre; Larimer County Canal No. 2, 1910, 1.12 acre feet per acre. All of these ditches have appropriations in excess of 25 second feet, but some of them do not carry this much water.
2517 In the year 1909 the flow of the stream was exceedingly large and in 1910 very low.

Cross-examination by Mr. N. E. Corthell:

The total capacity of the diversion works from the Poudre River in 1912, including reservoir inlets, was 3,486 cubic feet per second. Not taking into account the extraordinary freshets, when I believe I have seen 30,000 second feet of water in the stream, the maximum high water stage of the Poudre River is between 5,000 and
2518 5,500 second feet, so that that flow exceeds the capacity of the diversion works by from 1,500 to 2,000 second feet. The winter flow of the stream is more important than the flood flow because it covers a long time and can be all taken care of, whereas we frequently have to let a considerable part of the flood water get away.

2518 Redirect examination.

By Mr. Delph E. Carpenter:

3,486 cubic feet of water per second of time as total diversion for 1912 includes reservoir inlets. The question by counsel for plaintiff included diversion, and of course, that includes reservoir diversions. That does not include diversions made by channel reservoirs.
2519 They have no inlet ditches. It applies only to those diversions accomplished by canals. Mr. Clark asked concerning reported duties of water in acre feet during 1909 and 1910. In ascertaining these duties it was impossible for me to distinguish between amount of water diverted by ditch and amount used by lands under the canal. I simply reported amount diverted by canal regardless of whether the whole amount of water was used, with nearly all canals used to irrigate bottom lands, the bulk of the water returns to the river, and I have no way of stating how much water returned and how much was retained by land. It didn't make any difference because the lower ditches obtained the benefit of the return. For example, the John G. Coy Ditch takes water out of Poudre River for irrigation of bottom lands on bank of stream. It is a short ditch and returns water to river within very short distance of place of diversion. He uses the ditch sometimes for power purposes, and it is not always possible to ascertain how much of that water he is using for irrigation and how much he is turning back to the river. I simply referred to the diversion. Where I reported 7.94 acre feet for that canal for 1910, I simply meant that he diverted that much water into his headgate. I don't know what the actual duty of the water was for the irrigation of crops. It was not important to me how much of the water he used if it again returned to stream. This canal irrigates according to this report, 290 acres.
2520 As another illustration of this class of canal I might mention the Dry Creek Ditch and also the Little Cache la Poudre Ditch. Both these canals are used as reservoir feeders. This Little Cache la Poudre Ditch is the one in this report that I gave as diverting 3.18 acre feet per annum in 1909 and 3.41 acre feet in 1910. It is used to feed the Larimer and Weld reservoir commonly known as Terry Lake. It is actually used to irrigate about

1,600 acres of land. The Dry Creek Ditch was used to irrigate 2,200 acres of land in 1909 and 2,300 acres in 1910. For this canal I gave the duty in 1909 as 3.78 acre feet, and in 1910 2.94 acre feet. This ditch has very excessive appropriation as compared to land under it and it takes a great deal more water at times than it needs. It is also used as feeder for Long Pond. This reservoir gets water from river through this ditch and a portion of that water undoubtedly found its way into that reservoir. The owners of this ditch have contractual relations with owners of Water Supply and Storage Company Canal, by which Water Supply and Storage Company furnishes water of Larimer County Ditch to supply shares of stock owned by the Dry Creek Ditch and in lieu of the water for those shares of stock is permitted to go on down into Long Pond. I do not know how much of it goes into Long Pond. Com-
2521 piling the figures mentioned I simply reported the amount of diversions. All those figures in the column read by Mr. Clark refer to diversions only. In my report to the Division Engineer, I think I followed my general custom which is to let them figure out the acre feet. I reported the diversions in second feet. I did not embody in my report details of situation on the ground as I have enumerated them here. They were not cognizant of those facts.

Greeley No. 3 Canal of the Greeley Irrigation Company irrigates lands entirely underlayed with course gravel. The soil is
2522 thin. It takes more water to irrigate under that canal than any other canal on the Poudre River. These lands lie adjacent to Poudre River. They surround the city of Greeley. This is small canal with capacity of 100 to 120 cubic feet per second. It irrigates about 4,200 acres. It also serves water for city of Greeley for local use and for additional supply to that furnished by water works system. The canal is what is originally known as the city ditch for Greeley.

Whitney Ditch irrigates lands along river bottom. It is one of smaller canals. Capacity is perhaps 40 or 45 feet. Original appropriation was 48 feet, but it does not draw that amount all the time. Has very old decree and is entitled to all the water it wants, and generally takes it.

The B. H. Eaton Ditch has old decree and irrigates bottom land. It has excessive appropriation and appropriates all water that it has use for. They generally take all they care to run. I do not remember having shut the headgates of either of these canals during my life. It don't make any difference to me how much or how little they take. If they take more than they can use the surplus goes right back into the river and is available for other ditches below. There could be no actual waste in that regard.

Greeley No. 2 Canal, in addition to supplying lands with water for irrigation, supplies Windsor Lake, Seeley's Lake, and a few other small reservoirs. Water of Windsor Lake, in addition to being used for irrigation, is used to operate the sugar factory at Windsor to wash the beets during campaign. The work at the

factory consumes considerable water. This water is returned to the stream lower down.

2524 Pleasant Valley Canal, noted in tabulation appearing at page 66 of State Engineer's reports of 1909 and 1910 from which counsel read yesterday, is first canal that comes out of river below mouth of canon and is situated immediately at mouth. This was the fourth small canal constructed from Cache la Poudre River at beginning of our ditch construction. That was in the early 60's. It was constructed to irrigate a small tract of land on river bottom adjacent to river and was so maintained until 1879. Land is located inside of first hogback of mountains and on other side of Bingham Hill. This is little round valley of bottom hay land with a little farming. The bulk of the land was hay and they continued to use it that way until 1879. Then new people came into valley and found a lot of nice upland outside of hogback and they

2525 set about and homesteaded and preempted. They found only feasible way to irrigate this new tract was to extend Pleasant Valley Ditch and they went to the owners of this canal and made them proposition that if the owners of the ditch would deed it over to them and let them enlarge it and extend it to cover their lands, they would give the farm owners contract guaranteeing them all the water they wanted forever and would pay all expenses of maintenance. Superintendent of Pleasant Valley and Lake Canal has no control over the headgates, of the original owners. He does not open nor shut them. They simply help themselves.

When original adjudication of priorities was held, all these old ditches obtained excessive decrees. First appropriation for Pleasant Valley Ditch is No. 4 and amounts to 40.6 cubic feet per second, which is twice as much as could possibly be used on land in Pleasant Valley. In addition to this they obtained a later decree. Result is that people in Pleasant Valley holding these contracts draw excessive amount of water to irrigate this land on margin of river and a great deal of the water finds its way back into the river before it has passed Bingham Hill and out onto plains. In other words, this little valley known as Pleasant Valley is a small valley lying between mouth of canon and last range of foothills to east.

2526 River leaves these foothills at Bingham Hill. That is above headgate of Larimer and Weld Canal and most of other large canals.

Have consulted my report since testifying yesterday afternoon. Duties in acre feet as noted in the table from which inquiry was made by counsel were not calculated or noted by me in my report. In my report all I assumed to give was amount of water diverted by the various canals. This water was thus diverted under my supervision. The acreage given under the various canals is an approximation from best information I could obtain by talking with ditch superintendents and farmers under ditches. I never made a measurement.

Ditches diverting water and applying it along banks of Cache la Poudre River, occurring between mouth of canal and diversion by Ogilvie Ditch and which I used for irrigation of bottom lands,

are Dry Creek Ditch, Whitney Ditch, B. H. Eaton Ditch, J. G. Coy Ditch, Josh Ames Ditch, Bristol No. 1 and No. 2 from Box Elder Creek, Burnham and Emerson Ditch from Long Pine Creek. Very little difference is made in flow of stream by allowing diversions to these canals, because if they take more water than they need on the land, it returns immediately to the stream and we get a great deal of that which they use. There are other small ditches
2527 taking water from branches of the Cache la Poudre River and noted on this table. Conditions are practically the same with relation to these.

None of the ditches I have named are in any way to be compared with the larger canals such as Larimer County, Larimer and Weld, Greeley No. 2 and North Poudre System. The decrees of those smaller ditches are always excessive, more than they can possibly use. They are always entitled to water; whether they take more than they are entitled to or not is immaterial. For example, the John G. Coy Ditch has never been considered by me in carrying water down past the Larimer and Weld Canal. I regulate river at Larimer and Weld Canal to supply what I know is needed for larger ditches below that go out to irrigate land on plains. But in sending down amount required, I do not consider whether John G. Coy Ditch is irrigating or not. It makes no practical difference, and even if they are using water, the bulk of what they use goes back into river anyway and is available below for other ditches.

It is fact that larger canals irrigate very different kind of territory than that irrigated by smaller ditches along margin of stream. The territory irrigated by the larger canals is upland and has deeper soil and different sub-strata and the return waters from it do not get back so soon to the natural stream as they do from bottom lands on margin of stream. This is also true in large measure of those canals diverting water from South side of Cache la Poudre River and irrigating territory lying south and west of Fort Collins.

In Cache la Poudre Valley we have two classes of ditches
2528 taking water. There is the class of little ditches constructed in the 60's, most of which lie along margin of stream and cut little figure in ultimate distribution of water. There is then, the class of larger canals under which more intensive agriculture is practiced and where greater economy is used and where water is taken out on uplands and into plains district. In each instance, however, as the table of 1909 and 1910, as shown in State Engineer's Report on page 66, shows, my figures simply gave amount received at head of canal.

Total diversions of 3,476 cubic feet of water per second of time as capacity of canals taking water from Cache la Poudre River, as stated by me yesterday, includes all irrigating ditches and such irrigating ditches as are used for reservoir feeders. In other words, some of ditches are used not only for diversion of water directly from river for irrigation, but also for carriage of water into reservoirs. These figures include this class of ditches. It does not
2529 include those canals constructed or now used exclusively for diversion of water from river for delivery into reservoirs.

It does not include Poudre Valley Canal, which has thus far been used only as reservoir feeder. It does not include inlet from river to Cache la Poudre Reservoir. It does not include inlet from river to Fossil Creek Reservoir. There are also missing from this list some small ditches along river.

Referring to report of 1909 and 1910 and in conjunction with table appearing at page 66, which is part of chapter 6 entitled "Abstracts of Report of Water Commissioners," the following statement appears: "The first series shows for each ditch to which 25 cubic feet per second or more has been decreed. First and last day on which water was used, number of days water was carried, average amount of water, number of acre feet used, number of acres irrigated, duty of water under ditch, all for seasons of 1909 and 1910 separately. In some of the figures there is evidence of unreliability, but it is believed that most of them are correct. It was not thought best to omit any unless they were obviously incorrect." I am aware of that notation at the head of this abstract.

Halligan Dam of Halligan Reservoir is constructed across
2530 channel of North Fork of Cache la Poudre River, which is commonly known as the North Poudre. The lowest point in the dam is 70 feet high. Wings are 60 feet high from bottom of stream. Dam goes below bottom 15 or 20 feet. North Poudre River rises earlier than main stream and goes down earlier. The flow fluctuates a good deal. It has very heavy flows in that stream at times and at others it is very light. It is rather notorious as giving enormous flows for a short period of time. These flows are occasioned by heavy rains over very large watersheds. Construction of Halligan Reservoir has permitted us to distribute flow of North Poudre River more uniformly than we could in manner in which it came down naturally. Construction of this reservoir saves a great deal of water. When one of these floods comes down, we cannot make use of it as fast as it comes. We can hold it back temporarily and let it down in such a head as we can divert and make more economical use of it. In other words, this reservoir holds back water which otherwise would go to waste. This reservoir was first used in 1911.

Only waste of water we have in Poudre Valley is from large canals at points far distant from river, or from canals located right along margin of river. I attempt to keep track of those as far as possible and have assistance of other appropriators who might be
injured by excessive diversion by ditch in which they are not
2531 interested. If large canal on plains is wasting water while junior ditch is shut off, juniors are very willing and anxious to report those wastes to me. Owing to difference in priority, junior appropriator acts as detective on senior in matters of waste and never fail- to report it. When I receive those reports I check them up. Any waste or seeping water is generally turned into most convenient water course and back to river.

Waste water is never run into dead lakes and evaporation depressions over the territory. Wherever there is lake or depression where water accumulates, there are headgates and outlets so that water can be used. In case reservoir depression is so situated that

outlet gate cannot be conveniently constructed, they put in a pump and pump the water out. Pumping is usually done by electricity, sometimes by gasoline engine, where the power lines do not come near enough.

Water is considered to be of some particular value in Cache la Poudre Valley. The constant re-use of seeping water is caused by fact that we have a large acreage of land and are short of water with which to irrigate it.

2532 Some portion of water annually stored in reservoirs is rented. This is caused by fact that some people have more reservoir water than they could use on their places for that particular year. Consequence is that this water is rented to neighbors who do not happen to have enough. By virtue of my exchange system which we carry on in the valley, surplus water in most reservoirs is available for distribution and rent throughout the valley.

Price obtained for rental of reservoir water varies with different years. Water Supply varies with different years. Prices range from $40 to $160 per million cubic feet, for the season. In years of scarcity they are paying $160 per one million of cubic feet of water in the lake. This is generally reckoned at point of delivery to canal. Farmer bears proportion of loss in shrinkage and carriage from point of receipt at main canal to point of use. These prices

2533 are paid for water with which to perfect the crops. Our reservoir system is used as an auxiliary to our river supply, and always in the latter part of the season. The price which I have mentioned amounts to price paid for delivery of constant flow of one cubic foot of water per second of time for period of eleven and one-half days measured at point of delivery from reservoir into main canal. It is also the price obtained for 23 acre feet of water. This price does not include tolls or carriage charges necessarily incurred in carrying the water through the main canal for delivery to laterals. These carriage or toll charges are in addition to the rental charge I have mentioned.

Stock in reservoir which would yield annual quantities of water of one million cubic feet or 23 acre feet, sells on open market for from $700 to $1,000. This is price paid for one million cubic feet or 23 acre feet. After purchase he must carry the proportionate burden of maintenance and operation of reservoir. He must also bear toll charges necessarily incurred in carriage of water through canal to his land.

2534 Stock in these reservoirs is generally held by farmers. Exchange of capital stock by purchase or otherwise is general among farmers. Variation in price of reservoir water in case of purchase of stock is occasioned by location of reservoir and priority. Further up stream reservoir is, more ditches water may be used in, and this causes higher figure. Older priority of reservoir the higher the figure stock will command. Reservoirs depend on priority for filling. If priority is late, reservoir does not always fill, and in that case stockholder only gets pro rata share of what water is in reservoir. If priority is such that there is certainty of filling reser-

voir, the stock is higher in price than with one where the supply is doubtful. Price of reservoir water is not so much dependable upon nature of land to be served as upon geographical location of land and also priority. The land served is practically all upland.

Some of reservoirs have not been filled each year because there was not water enough available after prior rights were supplied. For that reason priority is factor in establishing reservoir water values.

2535 In making inspection trip to various parts of my water district, I go at irregular times in different directions, so that nobody knows where I am going.

I compel obedience to my orders to headgate men on ditches by reason of fact that when I find man violating my orders or stealing water, I don't allow that man to touch the headgates. Consequence is, man loses his job and man who takes his place knows why the former man lost his job, and if he does same thing he will also lose his job. I know of no other way in which I could regulate distribution of waters of stream correctly. By this method I have been able to substitute employees of ditch companies in lieu of deputies.

I do not make all of my inspection trips by days. I am on duty during the full 24 hour period. I never permit any warning

2536 to go out to where my next visit will be. During part of day I am carrying on a clearing house of the water of the Cache la Poudre Valley and during remainder of day I am on police duty. I generally do my figuring in mornings and evenings. During day I am generally out on line and sometimes at night.

Cross-examination by Mr. John D. Clark:

2536 I presume that the Poudre Valley prides itself on having the most efficient administration of the distribution of water and the most economical use of it of any part of the mountain region. I have very little knowledge as to the method of administration of use in other parts of the state, however.

The smaller ditches in District No. 3 are mostly old ditches in the river bottom and having early priorities so that it is not necessary to give a great deal of supervision to their use of water. In my opinion it is not a matter of much difference whether they take more water than they have an absolute need for or not, for the water will return to the stream very quickly. This return is not only through the water flowing from the end of the ditch to the stream, but through the water which has been spread over the land seeping back to the river.

2537 I do not believe that in my reports for 1909 and 1910 I filled out the columns showing the number of acre feet used through the various ditches. I believe that the data upon which the State Engineer made the report showing this item was secured from the Division Engineer. He made it from the balance of my report showing the number of days the water was carried through the various ditches and the average daily amount of water so carried, and the computation of the number of acre feet would be merely a

mathematical calculation made by the Division Engineer. My report also showed the number of acres irrigated, and this, while approximate, was intended to show the land actually irrigated and not the acreage contained in the entire tracts upon which irrigation was practiced.

2538 Among the ditches with early priorities and which do not materially affect the irrigation from the stream on account of seepage returned is the Dry Creek Ditch, irrigating about 2,300 acres. It is about 4½ miles long and carries water more than a mile distant from the river. Another such ditch is the Whitney Ditch which irrigates 3,500 acres, is four or five miles long, and the land irrigated may extend for a mile from the river. With a lateral at the end of the ditch it may be 7 miles long. Generally speaking, the larger canals are subsequent in priority to the smaller ones. Accord-

2540 ing to the State Engineer's Report for 1911 and 1912, page 70, covering all of the larger ditches in the district having appropriations exceeding 25 second feet excepting the North Poudre Canal, the amount of water used during the season of 1912 was 364,680 acre feet and the number of acres of land irrigated 190,880. Preceding this table is the following paragraph of the report:

"The first series of tables shows for each ditch the first and last day on which water was used, the number of days water was carried, the average daily quantity in cubic feet per second, the number of acre feet of water used, the number of acres irrigated, and the duty of water for each of the seasons 1911 and 1912. In some instances the figures given by the Water Commissioners' Reports were obviously in error, and such have been omitted. Other cases a part of the information desired could not be obtained. However,

2541 the table contain- a sufficient volume of information, especially on the much disputed question of the duty of water, to repay careful study. The tremendous variation in the duty is due partly to real differences in economy in the use and distribution of water, and in some few cases to inaccuracy in figures furnished by the water commissioners. By far the greater portion of this information, however, is believed to be substantially correct."

According to this table the average duty of water in 1912 in the district was 1.91 acre feet per acre.

2541 Recross-examination by Mr. N. E. Corthell:

In addition to the ditches in the Poudre Valley mentioned in my report as having a combined capacity of 3,486 cubic feet per second, there were three other ditches. The Poudre Valley Ditch has an estimated capacity of 400 second feet, but it is a new ditch, the banks of which are not settled, running around many hills in poor soil for the retaining of water, and when we have turned in 400 second feet the ditch washes out. The capacity of the inlet of the Timnath Reservoir is 70 second feet. The estimated capac-

2542 ity of the inlet to the Fossil Creek Reservoir is 400 second feet, but it will not carry that much and we usually run from 125 to 150 feet as a matter of practice. In regulating the diversion

of water into the ditches in the valley I do not ordinarily lock the headgates nor post notices.

2542 Redirect examination by Mr. Delph E. Carpenter:

According to table appearing on page 70 of State Engineer's Report of 1911 and 1912 and table to which counsel called my attention, total acreage served by ditches from Poudre River is noted at 190,880 acres. I check up that figure and find it is low regarding some of the large canals. Under Larimer County Canal, Larimer and Weld Canal, Greeley No. 2 Canal, they have been increasing their acreage more rapidly than I have noted in reports. I have not kept track of increased acreage at lower end of these three canals. I attempted to give acreage as nearly as I could approximate it from all information I could get from various parties, but there is tendency among some of those people who are extending canals, not to talk any more than they can help about new lands being brought under cultivation. They are afraid it might affect their rights.

2543 There is some litigation in courts now affecting that subject collaterally. This has been pending for several years and has not been decided yet. I have not been out to investigate in person to determine acreage under these extended areas.

If area given in table is too small, then increasing acreage would increase duty of water over that noted in table.

The years 1910 and 1911 were both years of very low water in the Poudre River. Effect of years 1910 and 1911 was that lands did not get required amount of water and they were very dry when the season of 1912 came. In 1912 irrigation began earlier and there was heavier demand because condition was not normal. Land was drier than normal. 1912 was year of large supply, that is, large compared with two previous years. There was a good deal more water available and farmers took advantage of it and used heavily. 1912 was above normal year in point of demand for water.

During recent months State Engineer put deputy in field to ascertain as accurately as possible number of acres irrigated in Poudre Valley. He found my reports were low on acreage and he had better means of finding out than I did, because he had nothing to do during the time and had more resources with which to do the work. We found that the acreage which I had been given in my reports was low on ditches which I have particularly mentioned. There were other errors but not so great as on the canals I have spoken of.

364,680 acre feet of water given in State Engineer's report for 1912, as number of acre feet used during season, does include water we carried over and did not use that year. It includes diversion, but there was a great deal of diversion that was not used that year. If reports show that at close of 1912 there was carried over 83,994 acre feet of water in reservoirs for use in 1913, that amount should be deducted from the total of 364,680 acre feet in order to get correct amount used in 1912.

Our main irrigating season closes in the middle of September and if we get a run then we go to storing water and this water is

reported on Nov. 1, 1911, and was probably obtained after we quit irrigating, because my recollection is we used all reservoir water in 1911 and did not have enough then. If there were 16,322
2545 acre feet in reservoirs November 1, 1911, that should be considered part of our storage for that winter. It was all used in 1912.

307,208 acre feet were used during 1912, after making due allowance for water carried over from November 1, 1911, 16,322 acre feet, and 10,000 acre feet held in channel reservoirs, and after deducting 83,794 acre feet, amount carried in storage November 1, 1912.

Duty of water for water used during 1912 would be 1.61 acre feet per acre, even assuming for time being that acreage of 190,880 appearing in report, which I state is underestimated, is taken as basis of calculation. The duty would be increased accordingly as acreage is in fact increased.

2546 Recross-examination by Mr. John D. Clark:

The headings and classification used in the tabulations upon page 40 of the report of the State Engineer of Colorado for 1911 and 1912 are identical with those on the reports which I made for those years, but instead of taking the separate ditches as I reported, the totals for all of the ditches have been here printed. Referring to Heading No. 12 showing the number of acre feet of water used by canals during the season, my impression is that in my report upon this matter in some instances I included all of the water diverted by the ditches irrespective of the amount used upon the land. I do not know whether this same situation exists with respect to the reports affecting the other districts in the state or not. The total amount of water used by all canals in District No. 3 in the year 1912 as given in this report is 419,368 acre feet and the total acreage of land irrigated in the same year is 224,180 acres.

2547 As part of my duties I have kept a record of the amount of water taken into District No. 3 which covers the Poudre Valley, from District No. 48, which includes the Laramie River. The report for 1911 shows a total of 18,874 acre feet, carried from District No. 48 into District No. 3, and I think this is very nearly correct. This covers the diversion through the Skyline Ditch. Whether it also includes the diversion through the Sand Creek Ditch I do not know, as I forget whether there was any diversion through that ditch in that year. The total amount of water carried from District No. 48 into District No. 3 for 1912 as given in this report is 28,068 acre feet. I do not know whether this includes both the Skyline and Sand Creek Ditches or not. I
2548 do not know whether the record upon this matter for 1913 has yet been compiled. I get reports once a week or sometimes twice a week from the man in charge of the Sand Creek Ditch showing the amount of water diverted by it from District No. 48. I can not, without referring to the records, state how much water is generally carried in that ditch.

2549 T. J. MONTGOMERY, a witness in behalf of defendants.

Direct examination by Mr. Fred Farrar:

Have resided at Fort Collins since fall of 1877. Am in real estate, loan and investment business. Came to Colorado June, 1866. Located at Golden City, now Golden, the then capital of the territory. Golden is 12 miles west of Denver. Governor Hunt was then governor of territory. There were no railroads west of Missouri River that spring when we left the river. Union Pacific railroad was building from Omaha west that spring. I drove 6-mule freight team to Colorado. Followed South Platte River.

2550 Was clerk in store and local telegraph operator at Golden. Line of telegraph came out following Platte River to Fort Sedgwick. The Fort was very near to Eastern line of Colorado just across river and 4 or 5 miles this side of present town of Julesburg. There was a branch line built from Fort Sedgwick to Denver and then to Central City, Colorado. There was another line which was formerly owned by Atlantic and Pacific Co., first line across continent, which went up Pole Creek 40 miles. Then line crossed over along Deer Creek to Muddy Springs and followed parallel with North Platte River, but back in bluffs to *which* is known as Chimney Rock or North Platte. From there it followed river to Fort Laramie and then westward to Fort Bridger. Just previous to that time they had constructed telegraph line from Denver northward by way of Fort Collins and on to Laramie Plains at Fort Saunders, and thence west. They had not made any connections when I quit the line. The original Atlantic and Pacific line had been purchased by the Western Union Telegraph Company. In *new* few months they connected their lines so that they did through business by way of Denver and north by way of Fort Saunders, and eventually abandoned line from Fort Sedgwick to Chimney Rock and by that route to Fort Laramie. They also constructed telegraph line from Cheyenne over to Fort Laramie and had one north by Fort C. S. Smith and Phil Kearney.

I think government had something to do with construction
2551 of that line in order to get communication with government post. Western Union Telegraph Company owned line time I was operator at Golden.

Closed telegraph office at Golden and reported at Denver. From there was sent to Fort Sedgwick. It was chief office west of Missouri River at that time. Division superintendent was located there. From there I went to Mud Springs, Nebraska. It was on plateau between North and South Forks of Platte River. Remained there until November, 1867, when was ordered to vacate office and report to Fort Sedgwick. Was out over the telegraph line during the meantime.

February, 1868, became acquainted with Union Pacific construction. Was engaged in work of construction of telegraph line of that road at time same reached Cheyenne. Construction of line was of temporary character and required repairs. I had charge of line repairs as well as installation of offices on frontier of road from time it left Cheyenne. Construction of telegraph line was maintained a

little in advance of construction of railroad. I installed offices as road built up.

Spring of 1868 first saw Laramie Plains. I installed first telegraph office in Laramie City, Wyoming, May, 1868. I went into
2552 Fort Saunders with orders from commander of post. I took instrument and batteries from Fort Saunders to Laramie the morning of the 20th of May. Installed office in Laramie that afternoon.

Union Pacific railroad reached Laramie City May 19, 1868. Am absolutely correct on day of month. On night of 19th track was just a little beyond Fort Saunders. That was 2½ miles from present city of Laramie.

I continued installing offices west of Laramie. I installed station at Two Rivers, known as Wyoming station. Present Wyo-
2553 ming station is not located at same place. Old station was at point they now call Two Rivers. I was operator at Wyoming station and remained there and ran office for a week or ten days. I continued to go on with the road, installing offices, but was at Laramie City a great deal, during 1868. Had occasion to go up and down Big Laramie a number of times. Used to go out Sundays hunting up river.

Hutton's Grove was location of stage station or ranch on
2554 Overland Stage road. Overland stages to California went that way. Amount of water in Laramie River is recalled to my mind, owing to fact that when we went into Laramie City the river was full of ties that had been cut up on Bull Mountain toward state line. These ties had been floated down river, were boomed at Laramie and taken out there.

Fort Saunders was constructed summer of 1866. I was clerking in store of my uncle who owned his own freight outfit. He had bull outfit and a mule outfit. We called mule outfit the "lightning express." In 1866, railroad having started west, Mr. Loveland thought it advisable to dispose of his freight outfits as we would soon be able to get our goods much nearer the Missouri River and I think I am correct in saying he sold a portion of these freight outfits and that they were taken up to Fort Saunders to haul out timbers from mountains in construction of posts.

2555 Remained in Wyoming until December, 1870. From there went back East. Made trip to Colorado in 1874. Returned permanently to Colorado in 1877. Was at Golden in railroad office about 30 days and then went to Longmont which was then terminus of old Colorado and Central railroad, now the Colorado and Southern railroad, where I remained about two months, and on completion of Colorado Central Railroad south from Cheyenne, was sent to Fort Collins and opened first office at that point. First portion of Colorado and Central Railroad terminated at Longmont and was constructed from Denver. After road changed hands, construction was commenced at Cheyenne and terminated at Longmont. It passed through Fort Collins on Cache la Poudre River. It was first railroad which reached Fort Collins or Cache la Poudre Valley in that vicinity. I went to Fort Collins October 7, 1877, and first train

entered town a few days later. Road was later constructed on to Longmont.

2556 Fort Collins had population of about 275 or 300 in 1877. Laramie City had had a railroad for nine years on a transcontinental line. Was first agent and operator at Fort Collins and worked in that capacity until July, 1881.

That portion of Colorado and Central railroad from Cheyenne to Longmont was built by my uncle W. A. H. Loveland. He was man I have mentioned as owning the freight teams. Present City of Loveland, Colorado, was named for him. First railroad service Fort Collins obtained was by way of Cheyenne.

Denver Pacific Railroad from Cheyenne to Denver had been constructed prior to 1877 but that crossed Cache la Poudre Valley at Greeley, Colorado. This road is now owned by Union Pacific Railroad. Think it was first railroad to reach Denver and shortly after that the Kansas Pacific reached Denver. Subsequently Colo-

2557 rado and Central Railroad was constructed from Denver to Golden and Longmont. By this way we had outside communication for that road.

June, 1881, the grading commenced on railroad up and down Poudre Valley. Prior to commencement of construction between Greeley and Fort Collins, Union Pacific Railroad was grading from mouth of Poudre Cañon up the river. This was done to block the B. & M. people who were in cañon surveying a route. When they had surveyed as far as the Narrows, they considered it impassable and withdrew to mouth of North Fork. They then surveyed line up North Fork of Cache la Poudre to Sheep Creek, up Sheep Creek and over Boulder Ridge into Cameron Pass. I gave notice to Union Pacific that B. & M. was at work in the cañon and they sent engineer out and he and I drove over there in evening. It was late but he discovered stakes and immediately went to Omaha and a few days later we obtained train load of graders and engineers and entire construction outfit and went to work in cañon and covered up stakes of B. & M. and they were grading when the B. & M. engineers were right where the dam of the Halligan Reservoir is now situate. This was before they had found out that our people were constructing. After it became known that B. & M. people were whipped out, they conceived idea of building railroad across to Greeley. Union Pacific built this line and incorporated it under name of the Greeley, Salt Lake and Pacific Railroad. They started that construction. They took largest part of outfit from cañon and constructed greater

2558 portion of line to Greeley that summer. That was in 1881. The Burlington and Missouri Railroad had not as yet constructed into Colorado. None of the roads up Poudre Cañon or the North Fork of the Cache la Poudre were ever constructed. When the whole scheme of building a railroad up the Poudre Cañon was abandoned, the grading outfit then turned their attention to construction of road between Greeley and Fort Collins. Construction of this railroad connected the Colorado and Central Railroad at Fort Collins with Denver Pacific Railroad at Greeley. The road from Fort Collins to Cheyenne was then abandoned. Abandonment of

this portion of road was due to fact that Union Pacific had acquired control of Denver Pacific and the Union Pacific grade from Greeley to Cheyenne was better than existing Colorado and Central grade between Fort Collins and Cheyenne.

Was elected county clerk of Larimer County, Colorado, in
2559 fall of 1881. Served four years. County seat of Larimer County was Fort Collins. After serving as county clerk purchased and resided on ranch on Sheep Creek for three years and operated ranch nearly five years when disposed of it. Sheep Creek is tributary of North Poudre River. It lies northwest of Fort Collins. After disposing of ranch returned to Fort Collins. First year was deputy secretary of State Agricultural College. At end of year went into real estate, loan and insurance business. That has been my vocation ever since.

My business has made me generally acquainted with agricultural conditions, especially those under irrigation. Have been in every agricultural district in Colorado and very largely over southern Wyoming and have made trips into other western states.

First time went back into Laramie River Valley was in 1885 and have been in various parts of that valley from Laramie City to headwaters of stream almost every year since.

My business has made me acquainted with farm values and matters which go to make up farm values. Have had a great deal to do with farms and farm lands. Was in Laramie Plains region during summer of 1913, from July 7th to October 1st. Was sent there by the attorney general of Colorado for purpose of securing whatever evidence or data might be of benefit to State of Colorado in suit now pending. Think I saw practically every section of land below Woods Landing to Laramie City and which was supposed to be under irrigation. I inspected the Little Laramie country. Inspected the country between Laramie City and Wheatland Reservoir. I visited the Wheatland district. Used an automobile.

From knowledge and observation of Laramie Plains region since 1868 and until present time, I cannot say that climatic conditions have changed any. It has always been to me the coldest, windiest country I ever knew. The climate is very cold. Springs are late and falls are early. They have frequent frosts during summer. Everyone seems to speak of country as being high, extremely cold, and windy, especially during summer. It is my experience that wind blows in Laramie Plains greater portion of the year. These winds are very cold. I would judge they blow from north and northwest, although they have winds from east and southeast. They have considerable wind in Cache la Poudre Valley. Difference between winds of Cache la Poudre Valley from those of Laramie Plains *are* expressed by fact that I never experienced as cold and chilly winds in the Poudre Valley as we had in the Laramie Plains. Whenever we get a cold wind in Poudre Valley everybody expresses
2562 it as having come from Laramie Plains. Prevailing winds in Poudre Valley are much warmer.

Climate is cool in Laramie Plains region during summer months; nights are quite cold. They are very different from climatic condi-

tions around Fort Collins and Greeley. There is vast difference between Wheatland outside of the range of mountains and the Laramie Plains region. Wheatland area is much milder in its claimate. Agricultural conditions verify this.

On July 30, 1913, very heavy frost in Laramie Plains. On morning of 31st I rode out past experience station near Laramie. Potatoes were black. I noticed that condition on all potato patches along that line of road. Don't remember just how far I went that morning but several patches along the road were badly frosted. I noticed that alfalfa was slightly affected, but it did not show very materially. I think it killed the potato vines.

2563 Frost in middle of summer is not unusual in Laramie Plains. I understand that it is not unusual to have frosts there any month in the year.

Crops which grew in summer of 1913 over plains of Laramie Plains region were native hay, alfalfa, a few fields of wheat, some oats and one or two small fields of wheat, some oats and one or two small fields of rye. Native hay seemed to be fair. Alfalfa was not what I would term a full crop. Oats were very inferior in my judgment. One field of wheat looked fairly good. Other fields did not look to be up to standard. When speaking of alfalfa was comparing with crops in Poudre Valley.

First cutting alfalfa Laramie Plains July 8 and 10, 1913. This was some three weeks later than cutting of first alfalfa in Poudre Valley. Two cuttings of alfalfa are obtained during summer

2564 on Laramie Plains. Second cutting alfalfa 1913 was during latter part of August and forepart of September. Best alfalfa I saw was on Grable Ranch and Hart Ranch.

Yield of alfalfa, first cutting, on Laramie Plains, did not in any way compare with first cutting obtained in Poudre Valley. The Poudre Valley crops seem to be so much heavier. Plants were thicker on ground and produced larger tonnage in Poudre Valley. Am basing these conclusions on my observations. Alfalfa did not grow to the same heighth as it does in Poudre Valley.

Oats in Laramie Plains would not, in my judgment, yield more than half as much grain as oats in Poudre Valley. I saw them harvesting their oats there in 1913. Did not see any threshing. Saw no evidences of any threshing. Saw one threshing machine standing idle. Think all the oats that I saw harvested were bound.

Potatoes were not extensively cultivated. My observations

2565 were quite general throughout the region. Made trips every day.

Uplands of Laramie Plains are noted for their coarse gravel. River bottom lands are those lands immediately joining the stream. In order to describe gravel on uplands it will be necessary to make statement in reference to lands lying under Pioneer Canal west of Laramie City. When you first reach neighborhood of Riverside Ranch, in fact, after passing Grable Ranch, going west and north to Little Laramie, ground that is broken shows coarse gravel from size of marble to as large as your *first*. Some fields are covered with large

coarse gravel, which I should term cobble stones. As you go
2566 towards Laramie you get out of the coarse gravel and there is a little more soil intermixed with the gravel. The gravelly condition diminishes some as you go toward Laramie. I noticed excavation near Laramie, soil seemed to have appearance of lime shale. There is considerable alkali, lime and gypsum in all the soil throughout the Laramie Plains. They have heavy deposits of gypsum. There are two or three manufacturing plants utilizing gypsum for plaster. Two of these mills are almost within the city limits
2567 of Laramie. Soda Lakes southwest of Laramie were once utilized. A railroad was constructed there for purpose of utilizing soda. Do not know how extensive the deposits were.

Did not observe any seepage excepting in portion of country lying west of Laramie City. I was forcibly struck with fact of seeing water along that road and on the ridge and standing in many places. Road itself showed where it had been graded up, that water was very close to surface. I think that condition extends over quite an area, three or four miles and probably a mile on either side of road. Don't know whether seepage is caused by Pioneer Ditch or from Lake Hattie, but there is quite an indication of seepage water close to surface. Would suppose it extends over three or four miles square.

Had occasion to go into Big Hollow. There was some water in there. Know Big Basin. Last time went through there they were running some water into the basin. Parties living there stated they were running water into basin. There was water in the lake. I made no specialty of obtaining the prevailing market price of lands on the Laramie Plains region. Prices were quoted to me on several occasions. I have learned what they are asking for them. I understand the water company was selling raw lands with water for $60 per acre, and some of the farm lands and ranch properties were quoted at $35 per acre with water, and I think I remember an instance where someone asked $20 per acre for lands without water. The lands for which $35 per acre was asked were average lands.

Laramie Plains region is absolutely undeveloped in comparison with Cache la Poudre Valley. Laramie Plains are about as far advanced as Cache la Poudre Valley was in 1868, excepting that I believe that Laramie Plains have more ditches today than we had at that time.

T. J. Montgomery.

2569 Cross-examination by Mr. N. E. Corthell:

The summer of 1913 was the only one I ever spent upon the Laramie Plains, and I have never been there for any considerable period of time at any other time. My almost yearly visits since 1885 have been upon fishing trips principally, and upon these trips I have travelled along the road from Laramie to Woods Landing and to Boswell's ranch, and sometimes have travelled by stage from Laramie into North Park. In 1913 I had no business upon the
2570 Plains except investigating conditions in the interest of the defendants in this action. While there I kept no records of

the direction or velocity of wind nor of the temperatures. The only frosts I noted were at the end of July and then again before we left, which was some time in October. In addition to noting the effect of the July frost at the experiment station I think I noted its effect upon one or two other patches of potatoes. One patch was across the road from the experiment station and may have belonged to it, and the other some place in the same vicinity. I made no inquiry or investigation afterwards to ascertain if the frost prevented the potatoes from maturing. While upon the Laramie Plains I lived at the Custer Hotel while in town. Once
2571 I stopped at the Sodergreen ranch for three or four days. the only vegetables from their garden that I recall were lettuce and radishes.

2572 I took no soil samples upon the Laramie Plains and made no investigations excepting as I could note the soil conditions where excavations had been made and where the ground had been plowed and broken. I am not a soil expert. In several instances I walked out into the fields where plowing was going on. I noted a difference in the soil conditions between the vicinity of Laramie City and the west side of the river. Near Laramie City the gravel is not as noticable as further to the west. I recall noticing some gravel in the soil in a little garden and in a field near
2573 Pahlow's ranch house and also at the point where the road from Laramie to Two Rivers crosses the North Canal. So far as I noted the soil in Laramie City is the same as that immediately west and across the river. I made no investigation of the alkali conditions at any place nor of the soda deposits.

2575 L. H. BAILEY, a witness in behalf of defendants.

Direct examination.

By Mr. Fred Farrar:

Reside at Ithica, New York. Vocation at present is writing and editing of books. Publications are along agricultural lines in a broad sense. Am editing series of books written by other persons along all kinds of agricultural lines, stock-raising, mechanics of agriculture, fruit growing, and like subjects. Am writing, more or less, books of my own on agricultural subjects, largely educational.

Raised on farm. Graduated from Michigan Agricultural College in year 1882. Spent two years at Harvard as assistant to Asa Gray, Botanist. Was not an assistant in Harvard University but personal assistant to Asa Gray. After that went back to Michigan Agricultural College for four years as professor, in horticulture and landscape gardening. And about 1888 became connected with Cornell University at Ithaca, New York, as Professor of Horticulture, and held that position for 15 years. Was then made Director of Cornell Agricultural Experiment Station beginning in year 1903 and continuing until close of last July, 10 years. In meantime I had developed this editorial and authorship work and I finally resigned

my connection with university and have devoted my whole
2576 time to that up to present. My whole life has been devoted to agricultural work, using the term in its broad sense and in relation to rural civilization and education.

My work and investigations have taken me into all states of the Union, with agricultural interests in mind, either educational or otherwise. Have made number of trips to Europe and in general through Canadian provinces, more or less, and West Indies as far as Trinidad. Think I have been in Europe eight times. Have been number of times to England, three or four times in Ireland, two or three times in Scotland, also in Norway, Sweden, Denwark, number of times in Germany, France, Austria, Italy, Switzerland, Belgium and Holland. The trips were all for purpose of studying agricultural conditions and subjects pertaining thereto, and education pertaining to agricultural efforts. Travels through United States and Canadian Provinces have been frequent. I think there has not been a year since I began public work, that I have not taken trips to some of them, at all events I have gone rather long distances.

I was chairman of Mr. Roosevelt's Country Life Commission appointed in 1909.

Could not give the books which I have edited off hand, but can give a number of them. For example, in Rural Text-Book Series, a book on Manures and Fertilizers by Dr. Wheeler, formerly of Rhode Island Station; a book on soils by Lyon and Fippin of Cornell University; a book on plant Physiology, by M. B. Duggar, now of St. Louis Botanical Gardens, and one on Southern Field Crops by J. F. Duggar, of Alabama. I am puting one through at present moment in that series, by Dr. Widtsoe, President of Idaho Agricultural College on Irrigation Practice. One on Farm Management is now on market, by C. F. Warren of Cornell University, and others in that series. Also, The Rural Science Series, comprising over 30 volumes. The Rural Manual Series comprising three or four volumes, and some others also. By the term editing I mean that I have the general editorial management of these particular series of books published by McMilland and Co. I arrange with the authors for writing the books, talk with them as to the plan of the work, what they wish included, and endeavor to inform myself as to wants for such books, and secure people to white other books to fill the needs. When manuscripts come in I edit them and put them in shape. In many cases I re-write them. I look after illustrations and in general see to form of book, general design, paging, etc.

2578 I have edited two encyclopedias and am now editing the third. First was Encyclopedia of American Horticulture, issued about 14 years ago in four volumes. That encyclopedia is being entirely remodeled now under title of Standard Encyclopedia of Horticulture, in six volumes. I released the first volume for printing last week. Present work is more comprehensive than former encyclopedia. Former was American encyclopedia and present includes many more plants than old one, comprising many plants offered by European dealers, because gardeners and horticulturists

of this country are now purchasing more supplies from Europe. It also gives more attention to tropical possessions of the country, as they have come into knowledge of our people since last encyclopedia was written. The third is The Encyclopedia of American Agriculture. The Encyclopedia of American Agriculture was issued four years ago. All these are edited by myself, but contributions are made by different men. I presume there are 300 persons now contributing in one way or another, to this encyclopedia, and the articles appear over or under their own names on the special topics.

I could not say how many works I have written, perhaps 12 to 20. Have written one of Country Life Movement, another on The Nature Study Idea, another took up The Outlook to Nature, another The State and the Farmer. These should comprise a set called The Outlook Set. I have also written a book on fruit-growing, The Nursery Book, Plant Breeding, Pruning Book, Forcing Book,
2579 Evolution of our Native Fruits, a book on evolution of our cultivated plants, Principles of Agriculture, The Farm and Garden Rule Book. Also three or four botanies for schools.

I am not at this time connected with Cornell University. My present vocation consists in my private editorial and authorship work. Have made good number of trips into middle west and further west for one reason or another. Not so much for investigation as to give addresses at meetings and was with Country Life Commission in its trip around country. That commission made trip from Washington through south to California, where it split, one branch going back through Nevada and Colorado, and another branch going north through Washington and Montana, both branches joining again at Omaha on to Boston and back to Washington. On that expedition I took northern route, coming back I did not pass through Colorado. Have been considerably interested in development in California. Had one hearing of Commission on Country Life at Bozeman, Montana, and one at Spokane, and also here, but
2580 before other branch of Commission at which I was not in attendance. Have been in Snake River Valley and at Twin Falls and looked that country over. I have forgotten the date, but think it was in 1910. I did not mean to say that the trip of the Country Life Commission was the only trip I have taken through this part of country. Have taken other trips west, largely going through to coast.

First visited Laramie, Wyo., a year ago last month. Was through Wyoming previous to that. Occasion of visit was installation of new president, Dr. Duniway of University of Wyoming. I delivered address on occasion of dedication of agricultural building. That was on same trip.

Have made trip over area known as Poudre Valley in state of Colorado and also Laramie Plains region in Wyoming. Made journey September 16, 17, 18, and 19, 1913. Arrived in Denver September 15, 1913. Trip was made at solicitation of attorney-general of Colorado, who desired that I look over the two areas in question in order to express my judgment as to which of the districts was producing greater wealth per acre, supporting greater number of persons

from products of land, and which would be likely to continue
2581 so to do in time to come. No indication was given me in correspondence as to what I was to look for beyond that. No statements were made as to character of two regions. It was desired that I should express my opinion as an outside person without any interference from any one concerned with the litigation. The plan, so far as either side of this controversy is concerned, was carried out, absolutely. I was given a perfectly free hand from first to last and I was surprised during the whole trip as to how careful persons were on both sides to endeavor not to bias my judgment. There was no effort to influence my statement and I was able to arrive at an impartial conclusion. I was not coached or interfered with.

I knew nothing about the two areas previous to that time, except in a general way. As to riding over it, I had never seen the Greeley region, or met a person, so far as I know, who lived in the Greeley region. I had seen Laramie Plains from train and had also been at Laramie last January at occasion of installation and there had met officers of Agricultural College and Experiment Station and a number of persons from surrounding country. Aside from that I had no knowledge of situation. I came as a stranger.

Request made of me was that I reach my own conclusions free from any suggestion or argument from any person representing state of Colorado, directly or indirectly, or from any of the defendants in this suit. That was not only the statement but it was carried out in practice, absolutely. During whole trip I don't know or recall that I asked for opinion on subjects I was expected to survey, unless I wished to volunteer it. They gave me every facility to see what I thought was best and worst.

2582 The trip through Poudre Valley Region was made by automobile. We traveled about 75 miles through Greeley District, exact route with distances being shown on map. Was accompanied by Prof. L. G. Carpenter throughout trip both in Colorado and Wyoming. Now and then other persons would be taken with us for greater or less time in order to point out to me some of the features of country. I think I saw average conditions in Greeley district. I was informed there are about 300,000 acres of land in Greeley District already improved and under ditch, and that the new project is to comprise about 125,000 acres, and I saw enough of that to satisfy myself, so far as I could by study in time at my disposal, that the district was practically the same as the adjoining district at Eaton.

I mean that the district included within the Greeley-Poudre Irrigation District is practically the same as the adjoining lands. It seemed to me to be so. My problem was therefore to determine what had been development of Greeley District.

After visting Greeley-Poudre Irrigation District lands I went up to Fort Collins region. My observations extended generally over Cache la Poudre Valley.

Went from Fort Collins to Laramie. Have not figured number of miles of travel in Laramie Plains, but my impression is that miles were more than in Colorado District, and I present here a map show-

ing course that was taken in the two days that we gave to Laramie region. We came into region at Tie Siding and then to Laramie, from Laramie we went on other side of river to Lund Orchard, to Sodergreen Ranch and to Riverside Ranch and back again to Laramie.

I understood that that country is irrigated by Pioneer Ditch.

Next day we followed marks of these road lines, going out in this direction in sight of James Lake, but not going to it. Went through Blackburn Ranch and following these road lines back, came out at Seven Mile Lake at Casterman's Ranch, and back again to Laramie.

Next day took trip back to Fort Collins way we came. Generally speaking we made reconnaissance of Laramie Plains country to south, west and northwest of Laramie. We included valleys of Laramie River and of Little Laramie River and went in sight of James Lake. I requested particularly that I should see best of Laramie Plains and I was told that I had seen it by the local people.

2583 I was left absolutely free and untrammeled by both sides at all stages of the reconnaisance.

After making reconnaissance I arrived at general conclusion as to agricultural conditions in the two regions, as much as I could arrive at it from short observations that I had made, and after I got back home, for my own benefit, wrote a statement of these con-

2584 clusions. I purposely did not read any reports before I made the trip or consult any of the census reports, desiring to secure my impressions from locations themselves as far as possible. After I returned I looked up census reports. I looked over soil survey reports of two regions, the government Soil Survey. I consulted certain bulletins and printed matter in regard to them, in order that I might check up my own observations and determine whether I had gone far astray.

It was three months after I made the trip, before I wrote anything like a formal report. Following my usual custom in such cases, I like to have the matters mature in my mind, to think them over, to arrive at what might be perhaps a safer judgment.

This formal report made three months after my trip was first report I made to State of Colorado.

In my own mind, these two areas, that is, Poudre Valley and Laramie Plains, are not to be compared. I contrasted them.

I might preface my testimony as to my conclusions and the reason therefor, of the development and future possibilities of the two areas, explaining difference and similarity, if any, by saying I have no possible interest in either of these areas. I have no interest in this litigation or its results. I was asked to express an opinion as to agricultural differences of these two regions and I have done so in as impartial a way as I possibly could. Of course, I have not been able to make any detailed study of farm management and farm practices of two regions. I have looked rather for certain marks of agricultural development which I have learned to look for in other regions. These, of course, were of general character.

I was very much impressed with development of Greeley region

by great number of people I saw everywhere, indicating rather densely populated section. Was impressed also by great number of teams I met on road and wagons carrying produce.

Was impressed also by great number of roads, following so many of section lines, indicating regularized and well laid out, well developed road systems, which indicates reather densely populated and productive section.

Was interested also in character of dwellings, their number, and I counted from four to seven houses to a section of land. Some places I think more than that. These houses looked to be established homes, mostly with good yards, some of them with small orchards about them, some of them with good vegetables gardens and good poultry establishments, and shade trees.

Was interested in number of vigorous share trees along highways and also in variety and vigor of natural vegetation along highways and irrigating ditches.

There were frequent schools. I was particularly struck and much surprised at number of thriving villages and small towns which I saw, such as Laramie, Ault, Windsor, Severance, and Eaton, all of which seemed, so far as I could determine to be real rural towns, that is depending upon agricultural development of region, and not being manufacturing towns, except as concerned sugar manufacture which is agricultural product.

Was interested in soil as I saw it, which seemed to me to be mellow, fine, fertile soil with relatively few deposits of gravel, and I saw very little alkali in this district.

Was impressed with fact that here was high developed agricultural region, impressing much as good agricultural regions do in
2586 much older parts of the country. Everywhere was evidence of thrift and ability to make a good living on the land. I was impressed with crops that I saw, alfalfa, beets, potatoes, and garden stuff. I saw good storage cellars, and sugar factories.

Altogether it seemed that in that region there was highly developed rural section founded directly on agriculture.

I do not mean to limit my observations entirely to the Greeley region. I speak in general terms of the whole region that I saw. I am speaking of course of developed region there, all tributary to Greeley and that country.

I then went over into Laramie region in Albany County, Wyoming and found very different state of conditions.

Country was more open with relatively small number of houses, relatively few teams on roads, very excellent roads but not so many of them laid out along rectangular lines as in the other region. Fewer shade trees and natural vegetation less vigorous.

I saw no rural towns outside of Laramie, founded on agricultural business. I saw fewer people everywhere outside of Laramie. Saw many very attractive places, some establishment that appeared to be first class, of course, were not so numerous as in the other region.

Soil appeared to me to be more diverse and various, in many parts topography was various. I was impressed that there was more gravel, at least visible, much of soil being coarser and I also saw some

alkali. I saw some good crops of certain things, but of course not nearly so many of them as in other district, and they were in places here and there and not continuous. Saw very little garden
2587 truck. So far as I recall, there are no fruit trees in bearing with single exception of those at Mr. Lund's place. This place is located southwest of Laramie and was furthest point we reached in travel. It is almost at Colorado-Wyoming line right on the Laramie River.

Became very much interested in Laramie region, even first day. Altitude, exhilarating atmosphere, assurance and enterprise, and so on, appeared to me. Became very much interested in this as problem in agriculture and wondering what was to be future of region. Saw good number of special crops and things on trial, largely at experiment station, which, however, I did not enter, because as I now recall, frost had killed a good part of experimental work of year.

I came away with distinct impression that, so far as new crops were concerned, practically everything was on trial as yet, and it seemed to me that the high development or intensive agricultural developments would be in special places where there is some particular peculiarity in soil and particularly where there is protection from climate.

The two regions appealed to me as being unlike and to be contrasted rather than compared. They represent different kinds of agricultural development and capabilities, with good points in both.

Laramie Plains struck me as being primarily a region of live-stock adaptibility and general Greeley District as already a highly developed cropping region.

It struck me that Greeley District, acre for acre, is capable of maintaining the more intensive and diversified cropping business yielding as a whole, more crop produce and sustaining a denser population from agricultural products of the lands. All these con clusions appealed to me as being self-evident.
2588 I arrived at these conclusions from my general observations of the two regions. Of course, when I came to analyze the observations, I find that they rest on two general classes of facts so far as I have been able to analyze them.

In first place, fact of actual relative lack of development of Wyoming district, as compared with Colorado district, and second, very considerable natural differences in elevation, configuration, latitude soils and climate.

If one goes into new or developing country as a stranger, he thinks he is able to judge very well of it by observing what has already taken place in older or developed parts near by. It is approximately only method one has to apply. Although these two regions were open to settlement at approximately same time, there is very marked difference in state of development of them.

Colorado region, under discussion, is of course known as one of the highly developed agricultural districts in the west. It has long ago secured and established reputation for its potatoes, sugar beets canning crops and other products. It is no longer a doubtful

experimental region or in the stage of pioneer development. The agricultural success of the region seems to me to be assured. So far as I could determine, as I have already testified, the new Greeley-Poudre District now proposed to be developed, has apparently as good natural adaptabilities as the adjacent region about Eaton.

By the new Poudre District, I refer to the lands of the Greeley-Poudre Irrigation district, and the extension of the area in only the extension of known and proven, permanent conditions.

2589 Laramie Plains district on other hand is sparsely settled. Average values as they were given me, were low as compared with Colorado region. Relatively little of land is under plow, and although there are certain well-established and apparently profitable ranches and establishments, region in general is as yet in its pioneer or at least its early stage of development.

In Colorado district under consideration, ranches or farms are small, indicating relatively intensive cultivation.

In Wyoming district they are large, indicating less production per acre. Of course there are exceptions in both cases.

I find by census figures that in 1910 average size of farms in Weld County, Colorado, was 229.6 acres, of which 103.1 acres, or nearly one-half, were improved.

In Albany County, Wyoming, average size was 2,361.5 acres of which 236.9 or about one-tenth were improved lands. These figures are an average for counties as whole, and I assume include irrigated and unirrigated lands.

How large holdings are in developed region in Weld County, Colorado, I have no exact means of knowing. I have made a good many inquiries of persons whom I met as to size of their holdings and found them varying. My general impression was that in those developed regions, the holdings as an average were not far from 80 acres. Of course, each of these holdings usually have a family, as I have heretofore indicated, one could count on these sections from four to seven houses. I assume that all hold families and I assume that those families would run from four to five persons.

I had only the permanent homes in mind. I did not count the shacks used to house the laborers at all.

2590 I have no desire to quote census figures for purpose of quoting statistics. I looked over census figures to see how far I might be wrong or right in my general conclusions. I have some of those figures, which I think I should like to state. Inasmuch as I am giving those, not for statistics, I am stating them in round numbers.

Acres of improved farm lands in Weld County, Colorado, I find in 1900 to be 251,000; in 1910, 410,000. In Albany County, Wyoming, 1909, 149,000; in 1911, 107,000.

Number of farms in Weld County, Colorado, 1900, 2,000; in 1910, 3,900. Albany County, Wyoming, 1900, 374; in 1910, 453. These figures, I wish to repeat, are all in round numbers.

Approximate value improved farms in Weld County, Colorado, in 1900 was $9,500,000; in 1910, $45,000,000. In Albany County, Wyoming, in 1900, approximately $2,750,000; in 1910, $7,500,000.

Value of all farm crops in Weld County, Colorado, in 1900, approximately $3,500,000; in 1910, $7,250,000. In Albany County, Wyoming, in 1900, $804,000; in 1910, $586,000.

Yield of wheat per acre in Larimer County, Colorado, 40 years average, was 23½ bushels. In Albany County, Wyoming, 30 years average, 19.1 bushels. Total oat yield Weld County, Colorado, 1900, 394,600 bushels; in 1910, 856,500 bushels. In Albany County, Wyoming, in 1900, 7,910 bushels; in 1910, 120,400 bushels. Yield in bushels of oats per acre in Weld County, Colorado, 40 years' average, 31½ bushels. Laramie County, Wyoming, 30 years' average, 22.8 bushels.

Total barley yield in Weld County, Colorado, in 1900, 150,700 bushels; in 1910, 577,600 bushels. In Albany County, Wyoming, in 1910, 10,300 bushels.

Barley yield per acre in Weld County, Colorado, 40 years' average, 30.9 bushels. In Laramie County, Wyoming, 30 years' average, 14.05 bushels, with fluctuations from somewhat over 8 bushels in 1890 to over 20 bushels in 1900 and 13 bushels in 1910.

Total product of potatoes in Weld County, Colorado, in 1900, 2,800,000 bushels; in 1910, 5,857,000 bushels. In Albany County, Wyoming, in 1910 approximately 50,000 bushels. Of yield of potatoes per acre in Weld County, Colorado, 30 years' average, 107.4 bushels, being above national average yield. In Laramie County, Wyoming, 30 years' average, 57 bushels. Tons of
2591 hay produced, I assume that this includes alfalfa and wild hay that is cut, in Weld County, Colorado, in 1900, 164,400 tons; in 1910, 168,200 tons. In Albany County, Wyoming, in 1900, 44,900 tons; in 1910, 52,700 tons.

Number of head of live stock in Weld County, Colorado, in 1900, 94,500; in 1910, 84,850. In Albany County, Wyoming, in 1900, 204,600; in 1910, 199,100.

I should say that I have not gone back of these returns of these statistics, considering the method in which these statistics are given, and they are not given for the purpose of giving statistics, but in confirmation of the judgment at which I arrived independently.

I assume that the number of livestock as shown by these census reports does not include number of cattle and sheep that have been brought into districts to be finished.

I think the history of such regions has considerable significance in arriving at conclusions such as we are trying now to arrive at. Very evidently productive and fertile regions develop first in any country, so far as they are accessible and can be made accessible. Laramie Plains had advantage of a transcontinental railroad. Both regions have had possibility of developing good water
2592 supply for irrigation. As far as I am able to judge, Colorado region under discussion has developed continuously, or nearly so, with practically all of its irrigable lands under good or even high state of cultivation. Laramie region has developed here and there in large ranches, with some smaller establishments and very much other space that is merely fenced and used for grazing.

Of course, it is evident on the face of it, that settlers have desired Greeley region more than Laramie region. Of course, I am stating this, not in any discouragement to development of Laramie Plains, that must be understood, but as an assertion as to how two areas struck me, and also as indicating that two regions are of very different character. I think this fact must be recognized when Plains region is fully developed. It seems to me that that region will undoubtedly further develop approximately as a grazing and to some extent as feeding region with such accompanying forage as can be grown with profit, and for the most part, this probably will mean its development in relatively large areas. Taking that country as a whole, as I saw it, it struck me as a region of relatively low crop production, both in totals and per acre, and also a fluctuating production, not overlooking the fact, however, of exceptions in particular places.

Now, while census figures do not show reasons in all cases, they nevertheless support in a general way these statements. The counties of Weld in Colorado and Albany in Wyoming are comparable as to size. I might say that I find a discrepancy in records as to size of Weld County. Figures I have show Weld County having 4,022 square miles. I have seen it given as 3,918 square miles. I have seen figures given for Albany County, 4,401 square miles, but they are near enough in size to be comparable for general purposes.

2593 What is more important in my estimation, they are comparable also in being rural, with one large town in each county of about 8,000 people. Greeley, in Weld County, has a population in 1910 of 8,179, and Laramie, in Albany County, a population under same census of 8,237. Total population Weld County in 1910 was 39,177, and in 1900 it has been reported at 16,808. Population per square mile in 1910 was 9.7. Rural population per square mile was 7.7, showing large percentage of population was rural. Total population Albany County, Wyoming, 1910, was 11,574. In 1900 the population of Albany County had been reported as 13,084. Population per square mile was 2.6 in 1910. Rural population per square mile was .8, or about one-tenth of population per square mile in rural district as that given for Weld County. I don't know what is population on developed farms in either of areas, as I have no means of knowing that. How large rural population is in developed areas of two regions I have no real means of knowing. Of course, it must be much larger in Colorado developed area than for Wyoming developed area. Chamber of Commerce of Albany County states that at least 50,000 more may find support and prosperity in the county. The large areas and relatively cheap lands of county are of course an inducement to settlers. Of course, we have no exact means of measuring what would be future development of a country. It will depend not only, in any case, on wants of country itself, but on a great many more or less important matters, as railroads, markets, and the like.

What has been done indicates in a general way what may be expected. Much of this development in the Wyoming country has

been under irrigation, further irrigation may be expected. An extended area may generally follow, it will do more to extend the area than to intensify the business. The history of the areas indi-
2594 cate a new development in Colorado region, that is, in the Greeley-Poudre project. This will be able to grow a large range of tillage crops, but the Laramie Plains, except in favored places, will be largely devoted to live stock, small grain, forage and hay.

The Colorado district is able to secure three cuttings of alfalfa, to grow beets for sugar, potatoes as high class commercial produce in large quantities, peas and tomatoes for canning, field beans, market gardens, and to a lesser extent, table fruits. Of course, it is also able to grow the same grains and hay as can be raised in the Wyoming region.

I am told in Wyoming region alfalfa produces two cuttings and that their main crops, aside from wild hay, are oats, barley, wheat any rye. It is reported that the grass and the grain has a very high feeding value. I heard mentioned possibility of developing and growing Canada field peas, turnips, and I think, heard flax mentioned. Potatoes are grown to some extent, yielding a relatively small tuber, said to be of high quality. Wyoming region imports a good part of its feeding grains, such as oats. Except as to favored localities under cultivation it does not produce orchard fruits or tender vegetables. Its supplies of these commodities are mostly imported.

I was very much interested in the Lund orchard, because of the fact that apples are grown at such a high elevation. I had not known of such a case at that latitude. The orchard is located in a very protected nook or cove, at the base of the mountains. It is very small, apparently has not been very highly cultivated or tilled, and
2595 therefore has produced a hardy growth. The trees were bearing, the fruits relatively small. There may be other coves or places where small farms may be successful, but I should hardly regard the Lund orchard as an indication of what can be done in the Laramie country. It was to me an exceedingly interesting test. I do not remember number of trees in orchard, but would presume about 100. The apples that I saw were small. Whether that was due to lack of tillage or natural conditions, I do not know.

I have spoken of some of reasons that reinforce my general impressions. I have gone over one of the classes of reasons lying in the history of the two regions, and these statistics as to the productiveness and yield. I might state very briefly of the natural conditions, which are quite unlike as between the two regions. I speak of soil.

Both the Colorado and Wyoming regions under discussion have been soil-surveyed by the United States Government. It is possible, therefore, to compare the nature and agricultural value of the soil conditions in the two areas, and to arrive at perhaps some useful conclusions as to the agricultural possibilities so far as the soil types themselves are indicative. Geographically the areas are located not far apart.

Latitude of Greeley is about 40.5 degrees and of Laramie is about 41.5 degrees. I have said that geographically the areas are located not far apart, and physiographically they are much more widely separated. According to chart of country, as published by the Soil Survey, Laramie is in the eastern edge of the Rocky Mountain Province, with average elevation of about 7,400 feet above the sea, while Greeley region is in the western margin of the Great Plains Region with an average elevation of about 5,500 feet, that being about 2,000 lower than the Laramie area. In order that I
2596 might make no mistake regarding the statements concerning the soil conditions, I had the two soil reports by the government gone over by an expert in order that I might get his conclusion. The chief difference in the structural geology of the area, is in the presence of more sand stone, lime stone and granitic rocks in the Laramie, than in the Colorado region under discussion and particularly in the presence in the Wyoming district of extensive deposits of gypsum. There is also a high salinity in the shales, which undoubtedly accounts for some of the surface deposits of alkali.

Since the soil surveys were made and the reports published, the Bureau of Soils of the United States Government has made a reclassification of some of the soil areas, and has renamed them for purpose of making their classification more uniform and the soil surveys of any region are now likely to be compared under this new schedule, that is, schedule of Bulletin 96 of Bureau of Soils, a large volume. It is supposed that this new classification represents better the soil relations. In first classification, under the original soil surveys, as far as that is concerned, the soils of the regions fall into three different classes: the residual soils which are formed from rocks breaking up in place; the deposit soils, deposited there by old or by recent rivers; and the colluvial soils, which are soils formed from transportation of material from hills or mountains. According to new co-relation, 29.6 per cent of soils on the Laramie sheet are residual in origin as against 7.7 per cent in the Greeley sheet. On the Laramie soil surveys, 54 per cent are given as consisting of old river terraces, while the Greeley region 12.5 per cent. Soils of recent alluvial origin make up about 15 per cent of Laramie area and about 7.7 of Greeley area. In Laramie area ancient river deposits
2597 of a sandy and gravelly nature are very prominent and through these areas protrude heavy to medium residual soils. In Greeley area, as surveyed and reported, the soil conditions comprise chiefly areas of ancient and recent river deposits of a loam to a clay loam texture, cutting through large areas of residual soil of a loam to a fine sand loam texture.

On the whole, the soil-survey reports seem to indicate that the textural properties of the soils as surveyed in the Colorado region are preferable to the textural properties of those surveyed in the Wyoming region. In the latter, the terrace soils are increasingly coarse in texture with depth. And in the Greeley region the reverse is usually or often the condition.

It would seem from these figures that the textural properties of the Colorado area, coupled with the larger rainfall, would favor the

maximum utilization of the natural water supply. In both areas there is white alkali. The two surveys do not seem to be comparable in all areas, or definite enough to allow exact comparisons to be made. Over considerable areas of the lower and better soils in Laramie the water table is near the surface and the alkali liable to be troublesome. I have no clear contrast of the amounts of alkali but they are larger in the Laramie area than in the Greeley area. These, in both cases, are white alkali and soluble.

In general the soil conditions indicate that the agricultural development of the Greeley region, as surveyed, far surpasses that of Laramie region. Of course, latter was quite new at time survey was made.

2598 The climatic differences between the two regions are marked, due to latitude, elevation and exposure. The Laramie Plains is one of the most elevated agricultural regions in North America, and is therefore one of the most interesting. Its development, in my estimation, will constitute a valuable experience for the utilization of other high and exposed areas, all of which must be brought into use in time.

We can project elevation into latitude, which will give another picture of the conditions, although, of course, we must not confuse elevation with latitude, because other elements enter in, as the length of day, although the elevation is in some respects equivalent to latitude.

We can get another idea of the relative situation, by saying that Laramie might be equivalent, other things being equal, to a point of general latitude of Edmonton, Alberta, although the two areas are not compared because other factors enter in.

There are two factors to be taken into account, principally in considering conditions in climate, one the temperature and one the rainfall. The temperature in the Wyoming district is universally several degrees lower than in the Colorado district, and the rainfall is two or three inches less in Laramie than in the Colorado district. I might give some details to illustrate this, taken from the official records:

The climate of the Greeley region of northern Colorado may be indicated rather closely by a long series of records kept by the regular Government Observatory at Fort Collins since 1874, and of course, those at Laramie are indicated by those kept at Laramie at a similar observatory beginning in 1890 and being complete from 1891. Records were kept at Laramie before that time, so that we have a rather long series of records from 1869, with a num-

2599 ber of years entirely missing, however. The records that I have here are made from the official records kept at Fort Collins and by the two combined records kept at Laramie. The exposures of the two instruments have been practically identical as indicated in the reports. The physical conditions of the two regions appear to be similar except that the nearest mountain range, about 5 miles distant, lies east of Laramie and lies west of Fort Collins. There is a difference in the elevation of the two instruments of something less than 2,200 feet. This difference in elevation is im-

portant, because it seems to be one of the reasons for a difference in the temperature of about 7 degrees Fahrenheit; that is, in the average annual temperature.

The annual mean temperature at Fort Collins is 47 degrees, and the annual mean for Laramie is 40 degrees.

Of course these figures do not represent exactly the situation at Greeley, but I think that for all practical purposes they are nearly enough accurate for that region.

Now this difference in temperature as given, called the annual mean, seems to persist throughout the growing season; for example, mean annual temperature for the months of March to September is as follows: Fort Collins, March, 35; Laramie, March, 28; Fort Colline, April, 46; Laramie, April, 37; Fort Collins, May, 55; Laramie May, 47; Fort Collins, June, 64; Laramie, June, 57; Fort Colums, July, 69; Laramie, July, 62; Fort Collins, August, 68; Laramie, August, 62. September, Fort Collins, 59; Laramie 53. That is a very uniform lower temperature throughout the growing season, beginning even before the growing season of about six or seven degrees.

This difference in temperature is what we would expect from the difference in elevation. The mean maximum day temperature also shows a similar condition. I think it is unnecessary to quote
2600 all the figures. The mean maximum night temperature shows a similar variation, it is unnecessary to quote that.

I think it might be well to quote the lowest temperature of record in those growing months: Fort Collins, March, –24; Laramie, March, –21. April, Fort Collins, plus 5; Laramie –10. May, Fort Collins, 23; Laramie, 16; June, Fort Collins, 31; Laramie, 26. July, Fort Collins, 36; Laramie, 33. August, Fort Collins, 38; Laramie, 32. September, Fort Collins, 22; Laramie, 8.

It shows that in all those months, there is a temperature at Laramie below freezing, except in August, when it was at freezing, and in July, when it was one degree above freezing. I am told that frost may be exected in July in some parts of the Laramie Plain. I was told that in Wyoming.

Of course, this gives Laramie a serious frost risk. It also has a comparatively short growing season.

The variations are very great in the precipitation as well as in the temperature. At Laramie in 1872 there was a total rainfall of 17.77 inches. In 1893 the observation showed 3.84 inches. The Fort Collins storms were as follows: Wettest year, 1891, 21.7 inches, and the driest year, 1893, 7.11 inches. The same year that Laramie had a rainfall of 3.84 inches, Fort Collins had a rainfall of 7.11 inches. The annual rainfall for the epoch under discussion is for Fort Collins, 14.81 and for Laramie, 11.11. I may say that this was made before I received Bulletin 100 of the Wyoming Experiment Station and these figures are, of course, not the same as in that, for that includes the Laramie region for a long number of years, but the same conclusions may be drawn.

There are no records that I know of, making the wind phenomena available for these two regions. It is understood the Laramie plateau is rather exposed and subject to strong wind current and the pre-

vailing winds are almost uniformly western, northeast and southwestern. They are usually from a western direction and the areas most exposed are the northwestern region, as I understand it from the maps.

So far as meteorological records are valuable for determining the fitness of these regions for agriculture, one would have no hesitancy in saying that the region measured by the Fort Collins records offers very decided advantages over that measured by the Laramie records.

Comparing the general improvements on the Wyoming lands, I should say they were less expensive and less prominent than on the Colorado lands, though there were some exceptions to that. My recollection is that the best establishments as a whole are in the Colorado district.

I do not know the reason for the excellent roads in the Wyoming district, unless it is due to the natural character of the soil. I was there during a very dry time. The roads over the Sherman Pass in that region, of course are very good roads and are quite ideal. The other roads looked to me to be well taken care of and well made, the main roads. What the surface would be in wet times I could not say.

I did not see any potatoes growing as a commercial crop in Laramie Plains region. My judgment is that there will never be a heavy potato crop commercially. I think they could be raised more cheaply in other regions.

The best crops that I really saw in the Laramie Plains, or
2602 saw the results of, were on the Blackburn Ranch. There are of course crops of native wild hay. To briefly sum up the principal reasons why the Poudre Valley area is in my judgment so much superior to the Laramie Plains areas as an agricultural region, I think I cannot do more than practically repeat the statement I have already made in my testimony. I feel that the development that is in the general Greeley district is one that is destined to produce more value per acre and greater diversity in cropping, will maintain a bigger rural population, and more rural industries founded on agriculture. The general fundamental reasons for these differences I have already indicated; I think chiefly are soil and climate, particularly the latter, for the reason it is difficult to overcome climate, but it is possible to overcome some difficulties of soil conditions. In other words, I should regard the climate to be a more important controlling factor than soil, other things being equal, if the soil is such that crops can grow in it at all.

I saw no reason for doubting that the area included within
the Greeley-Poudre Irrigation District could be developed
2603 as highly as the region about Eaton. Of course, to answer that with great positiveness, would require soil examinations and a careful survey. As far as a reconnoissance is concerned, I saw nothing that would indicate that it could not be developed as well as the other. There is no difference in the physical conditions. The soil is lighter in many cases than in the neighborhood of Greeley. There is much soil in the neighborhood of Eaton that is lighter and it seems to be the same general situation as far as I could determine.

L. H. BAILEY.

Cross-examination by Mr. N. E. Corthell:

The only time I made any investigation upon the ground in the Poudre Valley and the Laramie Plains was between September 16th and 19th, 1913, when I made an automobile trip over the two valleys and held conversations with persons along the road. Four days we spent on the whole trip and about half in each region,
2604 and we also returned through the Poudre Valley on the way back from Laramie City. Aside from my observations during this time my investigation has been confined to the examination of bulletins, reports and printed statements. Reports are those published by the Bureau of Soils of the Department of Agriculture, and in the case of the Poudre Valley the report was published in 1904 from soil survey by J. Garnett Holmes and N. P. Neill, and constitute a part of the sixth annual report of the Department of Agriculture, Bureau of Soils, for 1904. The data concerning the Laramie Plains region is founded on the publication of the Bureau of Soils, entitled Soil Survey of the Laramie Area, Wyoming, by N. P. Neill and party, advance sheet of field operation of the Bureau of Soils, 1893. This latter report covers the land lying within a distance of from two to nine miles west of the river and from one to six miles east of the river. Aside from these reports, maps, and the investigations I have mentioned, I have gained no information
2605 in regard to the soil of these two areas. I do not believe that the change in classification which has been made by the Bureau of Soils since the publication of these reports affects in any way the situation relative to these two valleys, the change not being one in fact, but only in the names of some of the soil types and in the origin of them. I believe that the names used in the reports covering the Greeley area and the Laramie area are comparable. As fas as the maps are concerned the land lying west of the Lara-
2606 mie River is more uniform than that in the Greeley area, but the descriptions will show that there is a considerable variation on the inside classification of the soil type. Little if any of the Greeley-Poudre Irrigation District is shown on the soil map of the Greeley area. The land lying east of the Union Pacific Railroad in the Greeley area differs in quality from that lying west of the railroad. I am not acquainted with the geological formations of either of the areas in question.

2607 From my reconnaissance of these two areas I arrived at certain conclusions in regard to the general characteristics of the soils, and I then asked a man connected with the soil surveys to go over the soil survey maps and to give me any comparison he wished to give of the soil conditions of the two areas as disclosed by the maps and soil surveys, and in my direct testimony I gave the results of his examination and comparisons. He did not know what was involved in the situation. As far as I know he had no personal knowledge of the conditions upon the ground, and his comparisons were based wholly upon the reports. My experience has generally been with

soils in the humid region and I have had no particular ex-
2608 perience with soils in the arid region and have given no special thought to any differences which may exist. I am not a specialist in soils. It is true that soils in the humid region are more likely to be impaired in their formation by acidity rather than by the opposite fault. This is quite a common condition in New York. There has been a great change of opinion in a great many agricultural institutions relative to the value of soil analyses. Some persons hold that chemical analysis is very important and others that it is incidental, and no generally accepted conclusion has been reached. I have given particular attention to horticulture more than to any other branch of agriculture while I was teaching it. I cannot state what the effect of two or three seasons of cultivation has been upon the texture of the soil in these two regions.

2609 I made no particular examination of the soils on the Blackburn ranch nor any comparison between the uncultivated and the cultivated lands upon the ranch nor between the lands on that ranch and the lands in other places upon the Laramie Plains. I observed gravel so frequently, particularly in cuts, as to challenge my attention, but I cannot state any particular place where I did note it. I made no particular examination of the soil in the vicinity of the Lund Orchard. I made no investigation to ascertain the conditions from which the livestock industry of the Laramie Plains grew. I should think that that country was devoted to stock
2610 raising because of its natural adaptability rather than to general farming. I have formed no idea as to how low much of Albany County, Wyoming, is mountainous and how much of it consists of plains. I suppose that the presence of large areas of mountain or dry land to the lands near the streams would promote stock raising. Weld County, Colorado, is altogether a prairie country. The difference between Weld County, Colorado, and Albany County, Wyoming, in this particular would modify the industries of the two areas to some extent, but I would say that the principal cause of the difference in the industries would be due to the general adaptability of the country. Other things being equal, I would expect to find more stock-raising in a country where there are mountainous areas than in a country where there are none. With respect to climate, temperature and rainfall are the principal factors, and where, as in this case, the difference in precipitation in two areas is not great, temperature would be the principal factor. Other factors are so important that I should not say that it is generally true that the higher the temperature during the summer season the greater the value of the land and the productiveness of the soil.

2612 I also based my judgment of the two areas partly upon a comparison of them relative to population and the intensity of cultivation. My testimony was that my judgment was based on the general impressions made upon my mind in this reconnaissance, and when I made an analysis I was conscious that these impressions were founded in the first place upon the facts as I saw them; that is to say, the actual development of the two places and also upon

the physical conditions, chiefly soil and climate. The difference in soil conditions was sufficiently marked for me to notice it. I have made no investigation as to the cause of the early development of farming in Colorado nor the effect upon it of the early development of the mining industry. I have assumed that the development in Colorado and Wyoming was upon equal terms subject to the difference in natural conditions and adaptability of the two regions. I have not assumed that there have been any artificial conditions affecting the development. There always are such artificial conditions but they are usually not controlling.

2613 I have stated it as a general proposition that the naturally productive and fertile regions tend to develop first, so far as they are accessible or can be made accessible. The early development of New England comes within this rule, as it was the accessible part of the country. If the Mississippi valley had been equally accessible, it would have been settled first. In my testimony based upon Census reports I took them for their face value and have not gone back of them to ascertain if they had sufficient basis. They were used to reinforce my general observations. I made no

2614 investigation of the potato industry in the Greeley district since 1910. The Laramie Plains is inclosed at least partially on the east, the south, and south-west and the west. The Poudre Valley is not inclosed, having mountains only on the west side. By the exposed condition of the Laramie Plains I had reference in the first place to the elevation and secondly to its exposure on the north and north-west from which many of the prevailing winds

2615 come. I did not mention the existence of mountain ranges around the Laramie Plains as indicating that they constitute a protection.

2615 Redirect examination by Mr. Fred Farrar:

I stated that there is some controversy as to the value of chemical properties of soil. There is no lack of uniformity of opinion as to the chemical analysis. Chemical analysis is important. The gist of that discussion is this, we have to consider the history of the matter. It was formerly thought that a making of the chemical analysis of the soil is a way to determine its fertility and productivity, and that was the thought a great many years. It has become established in the public mind that one may analyze his plant and analyze the soil and find exactly what to apply to the soil in order to produce the plant. Now we understand that the mechanical, physical and textural conditions of the soil also have a very marked effect and also the biological content has a marked effect, and in places where there is marked deficiency in any of these elements, a chemical analysis is not now considered to be so controlling as in times past.

I was told that the Blackburn Ranch which we visited was the best place in the Laramie Plains. This was the local information given me; that is to say, for a large ranch.

T. J. MONTGOMERY, recalled.

Direct examination by Mr. Fred Farrar:

I located at Fort Collins in 1877. When on stand at my former testimony I stated that Laramie Plains region today was about the same as that of Poudre Valley in 1867 or 1868. I wish to correct that statement. I would like to have the record read in 1877 or 1878, instead of 1867 and 1868. I was not living in Poudre Valley in 1867 or 1868. My comparison of the two areas is intended to be general and not specific.

I referred to the sale of lands in the Laramie Plains by the Laramie Water Company. That is the company which I understand owns Lake Hattie and the distributing system incident to it. The testimony I gave as to their selling lands at $60 per acre was hearsay, absolutely. I do not know of any case in which they
2617 sold their lands at that figure. I have been in real estate business for a good many years. I am familiar with farm values. I would say that the reasonable value of lands of the Laramie Plains for agricultural purposes would be about $15 to $30 per acre for lands under irrigation and cultivation.

T. J. MONTGOMERY.

2617 Cross-examination by Mr. N. E. Corthell:

I made no special inquiry relative to the price for which lands upon the Laramie Plains were selling and I have no knowledge about the sale prices of those lands excepting from hearsay.

Redirect examination by Mr. Fred Farrar:

I have followed testimony given in this case to some extent. I was familiar with survey made in behalf of the State of Colorado by Mr. E. C. McAnelly and his party on the Laramie Plains. If lands of the Laramie Water Company on the Laramie Plains are worth $60 per acre, lands under irrigation in the Cache la Poudre Valley would in my judgment be worth $300 to $500 per acre. I was advised that the Laramie Water Company were endeavoring to sell these lands to people recently from the east, people that they were bringing into the country. They were not attempting to sell the lands to people living in the Laramie Plains.

2619 E. C. MCANELLY, a witness in behalf of defendants.

Direct examination by Mr. Delph E. Carpenter:

Civil engineer, reside at Fort Collins. There for 30 years. Graduate of State Agricultural College at Fort Collins from department of Civil and Irrigation Engineering. My principal instructor during time of attending that institution was Prof. L. G. Carpenter. Engaged in practice of profession 14 years. Duties have been confined particularly to Cache la Poudre Valley. Work has been principally that of ditch and reservoir construction. During years

1913 and part of 1914 was State Deputy Engineer of Colorado. Particular duties assigned to me during that period were the making of surveys in the Big and Little Laramie Valleys. Made plane table survey of most of Big Laramie Valley. Was directed to survey and observe the irrigated portions of these two valleys. Entered
2620 upon performance of these duties in early part of June, 1913. Had full plane table survey party with me in charge of George P. Woodhall.

Made plane table survey of Laramie Valley from range lying on West side of township 76 following down Big Laramie Valley to little below Two Rivers. Also about six miles above Two Rivers on Little Laramie River with exceptions of a few sections in townships 14 and 15, range- 75 and 76 on the table land. I began some few miles north of the interstate line and about four miles from Woods Landing, Wyo. That point is at upper end of Laramie Plains. Laramie River Valley above Woods Landing is narrow. Mountains close in on plains near this point. Jelm and Sheep Mountains close in on valley here.

2621 There are ranches and cultivated lands in this narrow strip along the river between Woods Landing and the point where I commenced our survey. Starting at point of beginning of survey and naming the ranches upstream, they are:—Jacob Lund, Berg Ranch, and one other just below Woods Landing. This is same Lund Ranch concerning which testimony has been introduced by previous witnesses, upon which there are certain orchard trees. We began survey near Johnson Ranch. It is next ranch above Sodergreen's. We used the main road between Laramie and Woods Landing as the northerly boundary of our plane table survey work for a considerable distance down the valley. This is a diag-
2622 onal road. It is just on bench above bottom lands. Ceased to use road as northerly boundary when reached range line between ranges 74 and 75 west. From there on used North Canal, one of outlets of Lake Hattie Reservoir as northerly boundary. This canal marks upper boundary of area under ditch in Big Laramie Valley. Ground above that canal is bluff land used for grazing purposes and is not irrigated. North Canal is above Pioneer Canal. There is narrow strip of land used most for grazing. Used this canal down to point where North Canal swings to West and ends in Big Basin and from that point we took Pioneer Canal as northerly boundary and used that canal on down. North Canal swings to the west on Sec. 17, Tp. 16 N., R. 73, W. From there runs westerly towards Big Basin. I understand it terminates in that basin.

North Canal discharged water into Big Basin during 1913.

The highway which we used as northerly boundary for the western portion of the plane table survey, is indicated by two black parallel lines on topographic sheets for Laramie Quadrangle of the United States Geological Survey, edition July 1908, surveyed by E. M. Douglas, geographer. It runs in southwesterly direction from Laramie past Frazier Ranch, Seven Mile Lake, Nelson's Road Ranch, and Sodergreen's Ranch to Woods Landing.

During survey made reconnaissance of lands under canals lying

north and west of this highway and east of Sheep Mountain and Lake Hattie. This reconnaissance was to determine approximate number of acres in crops under different ditches. Under term crops I include native hay or any irrigated land. In making this reconnaissance where I had any doubt as to whether or not land was irrigated or had been irrigated, I resolved the doubt in favor
2624 of Wyoming. I did not make plat of land thus roughly investigated. Map area began and reconnaissance ceased near range line, between ranges 74 and 75 west.

On Little Laramie River ceased going up stream with plane table survey at point one mile west of Sprague's Lane. This lane is the north and south road on section line between Secs. 34 and 35, North, through Secs. 14 and 15, Township 17 North, Range 75 West. From Sprague Lane up Little Laramie River, survey was made by George P. Woodhall, he went with the plane table. The area above the lane was not mapped.

Plane table survey on Big Laramie River included area in vicinity of Wyoming Experiment Station and suburban residence of N. E. Corthell. My duties were to observe kind and condition of crops, etc. Party was in field from June 7th to September 19, 1913. Consisted of 7 men, engaged continuously during that time. Work was continued after September 19th under George P. Woodhall with one assistant. First camp located at Rickard's Ranch on Sec.
2625 12, Tp. 14, N. R. 75 W. Next camp was located on Solomon Ranch on Sec. 11, Tp. 15, N. R. 75 W. Third camp was located at Two Rivers on Sec. 5, Tp. 17 N., R. 74 W. Party worked from these camps. Plane table survey is method employed by United States Government in making its surveys and especially by U. S. Geological Survey in making its quadrangle sheets. Plane table consists of making picture of area of land in field. Plane table consists of draughting board and an instrument called the Alidade. Map is made in field by geographer in charge of instrument. Distances are obtained by stadia measurement and courses are platted right on map. Observations are taken by instrument. Elevations are taken by same method, although we did not note elevations.

2626 Our instructions on this survey were to include irrigated area along valley, different crops, location of buildings, ditches, and everything that was in valley. Geographer was to classify several crops.

During my observations of community took photographs of valley showing different buildings, different headworks, heads of different canals along both streams, the Big and Little Laramies. Part of photographs taken by myself and part by Mr. Woodhall. I have assembled these photographs in album, which will be introduced in evidence later.

Took measurements of hay stacks in valley to ascertain tonnage obtained from given area.

Have observed beginning of harvest of first cutting of alfalfa. Observed general condition of soil during progress of survey. Noted

that western part of basin was gravelly soil with large gravel. Some gravel probably 5 or 6 inches across. Largest gravel disappears along near range line between ranges 75 and 76, a little east of that.

2627 And from there on soil is more of sandy nature. Small gravel prevails even in the sandy soil. Best soil is west of Laramie in vicinity of Wyoming Experiment Station. In speaking of gravel being prevalent in western portion of basin I refer to Laramie Plains. Large gravel appears in vicinity of Sheep Mountain and continues in soil along Sodergreen High Line, Pioneer, Last Chance, Parker and Fischer Ditches. Gravel is so prevalent throughout this area that it can be observed by casual traveler. Soil on gravel in Sprague Lane on Little Laramie was six inches to a foot thick. On Lake Hattie inlet on Big Laramie gravel

2628 starts right on surface of ground. It is at surface.

Gravel, large or small, exists throughout the soils in Laramie Plains.

The topography of the Big Laramie Valley may be divided into three benches,—the river bottom, what is called the first bench, and the second bench or upland. We didn't cover highest bench with

2629 plane table survey. River bottom is land lying along river. It is flat and a little higher than the stream. A gradual slope from foot of bluff to river. Second bench is higher than river bottom land, with slope from foot of third bench toward river. Second bench on north side of Big Laramie River varies from about 6 miles to 1½ miles. Pioneer Canal irrigates second bench.

In making observations other than those noted on sheets, I observed irrigated lands from section lines. Travelled over lands and around them. Carried on these collateral surveys during entire period.

Direct examination by Mr. Fred Farrar:

Observations referred to were distinct and separate from plane table survey. Took observations of kind and character of crops raised on Laramie Plains during summer 1913.

Native hay is principal crop raised on Laramie Plains. Other crops are alfalfa, oats, some rye and some potatoes.

In making plane table survey platted whole country covered by survey. Have designated various kinds of crops raised. Maps or plats give definite information as to number and kind of crops on Laramie Plains. Acreage shown as devoted to any specific crop is accurate designation of true situation. Acreage is not conjectured but is result of survey. Distances were obtained by stadia measurements. Survey commenced in southwest portion Laramie Plains and progressed northeasterly and northerly to Two Rivers, from which point we surveyed southwesterly up Little Laramie. Started below state line, followed down Little Laramie River and then went up Little Laramie River.

2631 Very little alfalfa grown in whole Laramie Valley. Largest tract of alfalfa on Hart Ranch. Sodergreen has small tract and several small tracts close to Laramie.

First cutting alfalfa began on Laramie Plains July 7, 1913. A second cutting was obtained. Do not know day it started. It was last of August or first of September. Only two cuttings are obtained. I measured first cutting of alfalfa on Hart Ranch. There was one body of 481 acres which I considered all as one ranch. Hart Ranch is southwest of Laramie 7 or 8 miles. Lands lie on both sides of river. It is irrigated by Pioneer and Hutton and Bilderback Ditches. First cutting alfalfa on Hart Ranch measured July 24, 1913 in stack. Had not settled very much. Had been stacked about 7 or 10 days. We measured it and determined number of tons.

320 tons alfalfa hay in first cutting from 481 acres on Hart Ranch in 1913. Used same method measurement generally used for measuring hay in stack. That is same method used for hay which has settled. If there is an error, it would tend to show greater number of tons than actually existed.

Second cutting of hay on that ranch was later measured by Mr. Woodhall, under my direction, latter part of September or
first of October. It measured 252½ tons of alfalfa from
2633 481 acres, making total of 572½ tons of alfalfa hay obtained from that ranch in 1913 in both cuttings. Average production of alfalfa for two cuttings combined about 1.2 tons per acre. Some hay might have been sold before it was stacked. Stacks were not broken into, but some might have been hauled from win-
row. It is largest alfalfa field on Laramie Plains. Always
2634 considered it best piece of alfalfa on Laramie Plains. Formed this opinion from observing all of alfalfa on entire plains.

Measured first cutting alfalfa on Sec. 30, Tp. 14 N., R. 74 W., part of Hoge Ranch. Situate adjacent to Laramie River above Laramie, on southeast side of river, 13 or 14 miles above Laramie. 27.8 acres in field. Total number tons in first cutting, 30. First cutting measured four days after stacking on July 16, 1913. No deduction made for future shrinkage. Allowed same standard measurement which would apply to stack after it had shrunk. Yield of first cutting Hoge Ranch was 1.1 tons per acre.

Measured first cutting alfalfa on Sec. 14, Tp. 15 N., R. 74., part
of Buntin Ranch. 30 acres in alfalfa. Total first cutting
2635 production was 29.8, practically 30 tons. Did not measure second cutting. Ranch southwest from Laramie four miles, under Pioneer Ditch. This was all the alfalfa I measured.

Measured one field native hay on Little Laramie River on Al Bath Estate on Sec. 7, Tp. 16 N. R. 75 W. Mr. John E. Field and Mr. George P. Woodhall and I were present at time of making measurement. Hay was taken from 423 acres of meadow. Measurement made November 16, 1913. Measurement showed 253.2 tons of native hay, giving yield of 6 tons per acre. Do not know when hay was cut. Native hay generally cut middle to latter part of July. Only one crop of native hay obtained each year. The Bath place where this hay was located, I consider a good piece of hay land, one of very best meadows in Laramie Plains region.

2636 Gravelly condition of Laramie Plains extends over considerable area. Have noticed soil in Laramie City. They

were digging ditch for laying steam pipe. Excavation showed fine gravel all the way. Difference between this soil and soil southwest of the city is merely the difference in degree as to size of gravel.

2637 More or less alkali is present throughout Laramie Plains. You find it everywhere. There is considerably more alkali on Laramie Plains than in Poudre Valley. Alkali is evidenced by white deposit on ground surface. You generally find alkali in places where seepage occurs. Fact that alkali does not appear does not indicate that it is not present.

Soil under Lake Hattie Reservoir is similar to soil under Pioneer Canal. It varies from coarse gravel to sandy, gravelly loam up towards Laramie and North.

2638 Made examination of ditches in area. Most of headworks and dams across river are temporary affairs. I do not intend to imply that they are put in with the idea of moving them. Water will do that. They are made out of brush and loose rock. Most of headgates on Big Laramie are made of wood. I think there are two concrete headgates. One is at head of Lake Hattie Inlet at which point there is concrete dam. Other is at head of Fischer Ditch. These are new structures.

All diversion structures on Little Laramie were imperfect. Little Laramie area is devoted mostly to native hay. There are a large number of small ditches in this area. They are noted for the same temporary structures I have mentioned.

2639 Examined King Ditch. Head of that ditch is southwest of Laramie. Takes water from Big Laramie on south side. Examined King High Line Ditch. They both take water or head at the same place on the south side of the Big Laramie River. They have wooden headgates. Ditch is 14 feet wide on bottom and flows in easterly direction crossing Sand Creek over to Hutton Lakes. Concrete has been used for flume across Sand Creek and concrete drop on west side, and concrete check on east side of Sand Creek. Latter not yet completed. Waste gates have never been placed or had not last summer, and on east side gates were not in the check. Old Cunningham Ditch flows from Sand Creek into King High Line Ditch on east side of Sand Creek.

Water flowing into Hutton and Creighton Lakes stays there. King High Line Ditch is new. It is not yet completed. Water has been down ditch part of way but has never been across Sand Creek. Headworks of King Ditch are of wood. They are in fairly good repair at the present time. There was no diversion dam at headgate at the time I was there, June 24, 1913. There was no structure, absolutely, designed to divert water from river into King Ditch. There was no sign of any having ever been there. King

2640 Ditch comes out of King High Line Ditch. Where King Ditch leaves King High Line Ditch there is a drop and check in King High Line Ditch, but there is nothing in river.

Photographs taken by me during survey were intended to show character of headworks on different ditches, buildings, and surroundings in Big Laramie Valley. Phonographs show country covered by plats made in survey. In whole number of 500 to 600 photo-

graphs, about 50 did not turn out well. The photographs of the better structures and buildings came out right. Wherever we had a failure of one of the better buildings, or a better improvement, we took another picture. Any that may be missing are of poor improvements or poor structures.

2641 Plats made from plane table survey have been prepared for introduction into evidence. They are prepared by photographic reproduction and reduction of the original tracings.

(Defendants' Exhibit 114, an album containing photographic reproduction on reduced scale, of plane table survey plates, offered in evidence.)

Exhibit No. 114 is an album of 40 sheets, first sheet labeled index and sheets 1 to 40 showing improvements and vegetation in Laramie River Valley. This is photographic correct reproduction on reduced scale of plane table survey plates. On first or index sheet, scale is designated as one inch to 400 feet. That was scale of original map. That scale does not prevail on these photoghaphic reproductions. Each plat or sheet shows six sections of land. Sections 29, 30, 31, 32, Tp. 14 N., R. 76 W., and Secs. 25 and 36 Tp. 14 N., R. 77 W., are shown on sheet No. 1. From that as starting point, sheets follow down irrigated portion of valley. On index sheet there is plat showing sections numbered in various townships and ranges and there is large number commencing with 1 and running to 39 for each 6 sections. Larger numbers are sheet numbers. That shows

2642 sheets as they apnear in the exhibit.

Have prepared album from photographs of ditches, headgates and diversion dam in Laramie Plains region.

(Defendants' Exhibit 115, an album of photographs, offered in evidence.)

Defendants' Exhibit 115 is the album of which I have spoken The headgates and dams shown in exhibit are located along Big Laramie and Little Laramie Rivers, over area covered by plane table sheets, and also above that point. They include practically all headgates on Big Laramie River and most of them on Little Laramie River. Some of pictures of headgates on Little Laramie River did not turn out well. There was no discrimination in selection of headgates. We tried to obtain pictures of all headgates. Photographs were taken during summer and fall of 1913.

Number on map in front of this album shows location of picture bearing same number in album. Map is merely key to location of headgates geographically. In the legend under each photograph, first appears the number, then date upon which photograph was taken, and then what the picture represents and were located. It also shows stream from which diversion was made.

2643 Prepared album of photographs of improvements on area covered by plane table survey. It includes other buildings besides those shown on plane table survey.

(Defendants' Exhibit 116, an album of photographs, offered in evidence.)

Exhibit 116 is album concerning which I just spoke. Same arrangements have been made on map showing location of improvements. Map in front of album containing numbers in India ink, shows geographical location of areas shown in each respective picture. Each picture contains legend, giving number of picture, date taken, name of owner of place, and description by section and subdivision. Pictures of buildings are arranged according to section and township beginning on west and running from north to south. To make it clear, first township is 15 N., R. 77 W., and first picture is in Sec. 1. From there they run south through that tier of sections. Next series starts on Township 17, N., R. 76 W. and runs south. Runs to Township 13 S., R. 76 W. By taking map and commencing with Township 15 N., R. 77 W., first one, each succeeding range as you pass to eastward is shown in series. I referred to these pictures when I testified a few minutes ago that I had photographs of everything except in cases where there had been failure. Where there were important improvements concerned, and failure occurred, we went back later and took another picture. I have not intended to include anything in this album, showing improvement within city of Laramie.

In Defendants' Exhibit 115, there are 167 pictures showing ditches and headgates. In Defendants' Exhibit 116 there are 245 photographs showing improvements. There was no discrimination as to what improvements we took. Purpose was to try to take all of improvements to show character of country, buildings, and all improvements. Photographs contained in Exhibits 115 and 116 were taken by myself and George P. Woodhall. Laramie Plains area is contained in album Exhibit 116. It shows improvements from upper end of Plains down to point about six miles below Two Rivers. Two Rivers is junction of Big and Little Laramie Rivers. Took photographs of all improvements to point above six miles below.

2645 We only took photographs of improvements within irrigated sections. This does not go down as far as Wheatland Reservoir. From Two Rivers on pictures include buildings on river bottom and not up on bench. Exhibit 116 is complete album giving comprehensive view of improvements on Laramie Plains outside of Laramie City.

Exhibit 114, sheet 1, plane table survey exhibit, shows ranch of J. E. Johnson, part of Oscar Sodergreen's place, and some of A. T. Durand's place. This plat shows location of county road between Laramie and Wood's Landing, Sodergreen High Line Canal, Lake Hattie Inlet Canal, Headgates and portions of these canals, headgates and portion of Popp and Barlow or Last Chance Ditch. Popp and Barlow and Last Chance are same canal. The canal I de-

2646 scribed as Popp and Barlow other witnesses have described as Popp and Pahlow. Portions of other ditches are also shown on this map. Cultivated area is designated by characters, also names, as "oats," "potatoes," "garden," "plowed ground." All are labeled. I have arranged a legend showing how township lines are represented, section lines, subdivision lines, fence lines, barb wire fences, pole fence , telephone lines, grains, alfalfa, potatoes, plowed

ground, meadow l[illegible], pasture lands, grease-wood, bluffs, trees, and roads. Legend is o[illegible] first sheet of album.

Sheet No. 2 of album, Exhibit 114, shows classification of meadow lands into second and third classes. I made classification of meadow lands into first, second and third class. First class meadow is meadow that would cut one-half ton of native hay, or better per acre, and with good stand. Meadow which will cut less than one-half ton of native hay per acre, was classified as second class; and third class meadow is meadow that, while it might be cut in spots, is more useful for pasturage than meadow.

2647 Places that I have labeled as pasture is not what counsel for Wyoming termed irrigated pasturage. That is not irrigated land. Irrigated pasturage, as the term is used by counsel for Wyoming, is designated on these sheets as third class meadow.

For illustration of Exhibits of 114, 115 and 116, I refer to sheet No. 1 of Exhibit 114, album of plane table survey. On that sheet appears canal which heads near center of Sec. 36, Tp. 15, N., R. 77 W., which is labeled Laramie Canal. That is inlet canal to Lake Hattie, owned by Laramie Water Company. That is canal described by Wyoming witnesses as Lake Hattie Inlet, being enlargement of Pioneer Canal at that point. Referring now to Exhibit 115, picture No. 119, shows headgate of this canal. Picture No. 120 shows dam across river at that point. Referring again to Exhibit 114, next canal down river is Parker Ditch, heading near eastern line of same section. Photograph No. 139 Exhibit 115, shows headgate and diversion dam at that canal. Shows structures on Big Laramie River. On Exhibit 114, Popp and Barlow Canal shows as heading near center of N. ½ of Sec. 31, Tp. 14, N., R. 76 W. In Exhibit 115, photograph numbered 126 shows headgate of that canal and photograph No. 125 the dam. Headgate is wooden structure. Dam consists of loose rock and brush. There is wooden measuring weir below headgate in that canal. Headgate is not very permanent wooden structure, poorly constructed. It is not satisfactory device under any modern system of irrigation. The gates are fairly good, it is constructed of planks laid lengthwise. I have seen such headgates diverting water from Poudre River. They are not prevalent down there. They are putting in more permanent structures there now than they used to have, although there are wooden gates yet.

Next canal shown on sheet 1 of Exhibit 114 is Sodergreen Ditch heading in same section as Popp and Barlow. Photograph No. 124 in Exhibit 115 shows headgate of that canal and photograph

2649 125 the dam. Pictures is wooden. Dam consists of dam and headgate. Headgate is wooden. Dam consists of loose rocks, logs, and some concrete. Headgate not in good repair. It is not permanent structure. There is no modern operating device for headgate.

Next canal appearing on sheet 1 Exhibit 114 is Fischer Ditch, heading near north line Sec. 32, Tp. 14 N., R. 76 W. Picture 127 in Exhibit 115 shows headgate and dam of Fischer ditch from Big Laramie River. Diversion dam consists of loose rock and log dam.

Headgate is concrete structure with screw lifting device. This headgate more nearly approaches modern device.

Riverside Canal No. 2, heading in same section as Fischer Ditch, appears next on sheet 1, Exhibit 114. Photograph No. 128 shows the structures at that point of diversion. It shows headgate and dam. Dam consists of loose rock and brush. Headgate is wooden structure made out of poles for top cross piece and with plank sides.

Next canal shown on sheet 1, Exhibit 114 is Olson Ditch, heading immediately below Riverside No. 2. Picture 129 in Exhibit 115 shows character of dam, made of trees, logs, brush, and loose rock. Material just piled in and not laid symmetrically. Headgate wooden structure, consisting of two gates.

Durand Ditch next appears on sheet 1, Exhibit 114. Photograph 130, Exhibit 115, shows diversion works of that canal. Works consist of loose rock dam, headgate is modern structure consisting of two gates.

Hammond Ditch appears next on Exhibit 114. Picture No. 131, Exhibit 115, shows headgate of that canal.

Other than Lake Hattie Inlet Canal, designated on sheet 1, Exhibit 114 as Laramie Canal, headgates of various canals taking water from Big Laramie River are not of generally permanent nature. Ditches themselves are not in good shape and not kept clean. More or less grass or weeds grown along ditches. Willows grow in them. Ditches do not indicate very good farming.

Sheet No. 1, Exhibit 116, Upper plate shows Johnson Ranch. Picture No. 64 shows improvements on that ranch. Improvements numbered previous to No. 64 in Exhibit 116 are on sections to north and west of Johnson place. Picture No. 63 shows improvements on Sodergreen place. Photographs in this album, Exhibit 116, are arranged according to sections, beginning with section 1. Sodergreen place is on Section 29, Johnson buildings on section 30. Sodergreen buildings have the number 63 and Johnson buildings No. 64. Sodergreen Ranch is one of best in point of improvements on Laramie Plains region. Johnson and Sodergreen places are at extreme upper end of Laramie Plains, just below cañon in Laramie River. Sheep Mountain is on north side and Jelm is on south side of these ranches.

Photographs shown in Exhibits 115 and 116 were taken under all conditions. At times light was adverse and also weather conditions were sometimes adverse. That is reason some photographs are clearer than others.

2652 At times names I have used to designate places or ditches are not exactly same as those used by Wyoming witnesses. In these cases, I obtained names as best I could while making survey. This accounts for difference.

Photographs contained in Exhibits 115 and 116 give fair representation of character of improvements. There was no attempt made to take adverse picture. Object was to take photographs of everything. I tried to take fair pictures showing real conditions.

Referring to album, Exhibit 115, containing photographs of headgates and diversion works on Big Laramie River going down stream,

description of each set of diversion works, with number of pictures, are:

First picture, No. 122, at upper end of valley is photograph of structures located at Woods Landing on Sec. 11, Tp. 13 N., R. 77 W. Dam consists of loose rock. Headgate wooden structure; name Berg Ditch. Next ditch is Sodergreen High Line, heading in Sec. 36, Tp. 14, N., R. 77 W. Photographs No. 121 and 141 show headgate and dam. Dam consists of loose rock piled across Laramie
2653 River. Headgate of would in good condition, comparatively new. Headgates of Berg and Sodergreen High Line Ditch are both above point where started plane table survey. They are not shown on plat. King High Line Canal is shown by picture 136. The dam is shown by picture 135. A dam of poles appears in picture. It was not there when I made observation from which I stated that there was no dam in river at head of King High Line Ditch. Picture 132 shows Mansfield Ditch located north side Big Laramie on Sec. 2, Tp. 13 N., R. 76 W. There is no picture of diversion dam. Riverside Canal No. 1 located on north side Big Laramie River on Sec. 2, Tp. 13 N., R. 76 W. Photograph is No. 134. Dam consists of loose rock structure built across river. Headgate of wood. Dam is merely irregular pile across stream. Caldwell Ditch is pic-
2654 ture No. 118. No diversion dam on river. Headgate consists of wood. Structure is not up to date. Picture No. 117 shows next ditch, Cuba ditch, north side of Big Laramie River in Sec. 29, Tp. 14 N., R. 76 W. Gate consists of wood, structure in fairly good condition. Ditch is newly constructed. Was constructed about one year ago and is in fairly good shape. Hoge and Haley Canal is located on south side of Laramie River Sec. 29, Tp. 14, N. R. 75 W. Photograph No. 116. Headgate consists of wooden structure; it is poorly constructed. There is no diversion dam. Nelson Ditch is located north side Big Laramie River, Sec. 21, Tp. 14, N., R. 75 W. Photograph No. 142. Wooden headgate and no diversion dam. Bush and Holliday Canal is located south side Big Laramie River in Sec. 21, Tp. 14, N., R. 75 W. Photograph No. 137. No diversion dam across river and has headgate of wood in poor condition. Dowling Canal located east bank Big Laramie River Sec. 32, Tp. 15 N., R. 74 W. Dam consists rock crib. Headgate wooden structure in good condition. Photographs numbered 149 and 150. Next canal is old Walcott Ditch, located north bank Laramie River, Sec. 22, Tp., 15 N. R. 74 W. Photograph No. 157. No headgate and no dam across river. Ditch has evidently been abandoned.

Remaining photographs in this exhibit were taken by Mr. Woodhall, and not by me.

2655 Referred to album, Exhibit No. 114, containing plane table survey sheets, on each of some of sheets appear small letters referring to another sheet numbering, for illustration, on sheet 9 appears small letters at top of sheet "No. 8." That indicates that if they were spread out in map form sheet No. 8 would simply join sheet No. 9 on north. In each case I indicate reference to another sheet. It indicates No. of sheet joining on proper side.

E. C. McANELLY.

2656 Cross-examination by Mr. N. E. Corthell:

Prior to 1913 my only acquaintance with the Laramie Plains was in passing along the Woods Landing road upon the old stage. Substantially all of my time from June to September, 1913, was spent upon a survey upon the Laramie Plains. I was not with the party all of the time, but it was in my charge. Part of the time I held the rod, sometimes I was up on a hill taking pictures and sometimes I did other work in connection with the actual surveying. The particular pictures I took are those showing the headgates and buildings. I believe I took more than one-half of all of them. I did no personal work upon the maps and did not handle the instruments. We dug no test pits to examine the soil and the only investigations we made were from surface conditions and where excavations had been made. No samples were taken. The gravel continued to some extent all the way from Laramie City to Sheep Mountain. Anywhere along the Woods Landing road, which is a graded road, the gravel can be observed, being finer near Laramie City. I observed a gravel pit about one hundred yards from the river near Laramie City and observed it at other places between that and Sheep Mountain. Any amount of gravel can be seen west of Mr. Grable's ranch, and east of Grable's ranch you will find it by Nelson's place, and east of that it gradually becomes less as you go towards Laramie City. I did notice that last summer fresh gravel had been hauled to the Woods Landing road, but I do not know how far they had hauled it.

2659 The excavation I saw in Laramie City was near the post office where steam pipes were being laid, and where gravel was noticeable. There is a difference between the soil in Laramie City and that on the west side of the river. On the east side of the river the red sandstone and shale formations are found. Coarse cement gravel is also found in Laramie City, but I do not know whether it is found on the east side of the river outside the city. I did not see any excavations of the same depth on the west side of the river, so cannot compare conditions. I do not know how

2660 much alfalfa may have been hauled from the fields upon the Hart ranch and how much of it was stacked. The acreage of 481 acres, including three patches on sections 21, 29 and 31, was, I believe, all cut over for the first cutting. I do not know about the second cutting. I did not measure any alfalfa on the south side of the river on the Hart ranch under the Hutton or Bilderback ditch. The formula I used for calculating the tonnage of hay in the stack was to take the width plus the over and one-fourth of that squared times the length and divided by 512. I think 512 is the

2661 number of cubic feet to a ton of alfalfa hay in the stack as commonly computed on the Laramie Plains. 422 cubic feet is used with native hay but so far as I know not with respect to alfalfa. I have no knowledge as to the method employed in measuring alfalfa on the Laramie Plains, and only know what Mr. Titus testified relative to the measurement of native hay. In measuring the native

hay on the above ranch I used 422 cubic feet instead of 512 in the same formula. The acreage of meadow land on that ranch as I have given was the acerage actually cut over in 1913. I know nothing about the custom of pasturing cattle on these meadows after the hay is taken off. I do not know whether any hay had been hauled away from the Bath meadow, but none of the stacks had been cut.

2662 The only alfala fields on the Hart ranch were as follows: On Section 14, 70 acres; on Section 21, 266.2 acres; on Section 22, 5.3 acres; on Section 27, 12.2 acres; on Section 29, 135 acres; on Section 31, 79.8 acres; on Section 34, 6.1 acres. The 70 acre tract in Section 14 was not entirely cut over, about half not being cut. The 35 acres cut produced approximately 30 tons in the first cutting. The only alfalfa land I found in Section 14 was 70 acres.

2664 In Exhibit 116 the collection of photographs showing, with a few exceptions, all of the buildings and improvements outside of Laramie City upon the Laramie Plains, I did not include the improvements on unirrigated lands. Pictures were taken of all improvements under the constructed ditches. Whether pictures were taken of improvements upon lands to be covered by the Stuart Ditch now under construction I do not know, as Mr. Woodhall took the pictures in that territory. The legend at the beginning of Exhibit 116 was prepared in the State Engineer's office, and not by me. My only purpose in taking the pictures was to secure a fair

2665 representation of the structures, buildings and surroundings, and in each case I attempted to procure the clearest and most representative picture. I did not take pictures Nos. 1, 5, 6 or 25. No. 9 may be a picture of premises belonging to C. W. Weber instead of J. Weber. It shows the first buildings below Woods Landing on the River. All I know about the building shown in No. 32, designated as vacant, is that nobody was there the day we took the

2666 picture, and the same is true with No. 35. Some of the pictures of buildings which we considered unimportant were taken at some little distance. This is true of Nos. 31, 32 and 37. No. 235 was taken from a road I do not believe 1,200 feet distant from the building shown. I do not believe that the building

2667 there shown cost as much as $2,500, but I did not examine the house from any near point. I would say that this picture No. 235 was a fair representation of the premises and improvements even though it was taken at a point which placed the half-acre alkali patch in the foreground and, as assumed by counsel for Wyoming, a highly productive market garden patch of 8 acres and a $2,500 house in the distance. It is true that in some cases, possibly 24 or 25, the pictures were taken at long range with uncultivated land in the foreground and the buildings far removed in the back-

2668 ground. Picture No. 118 showing the ranch of Cyrus Billip was taken from the road, perhaps a quarter of a mile from the house. The improvements consist of a good barn and a small white frame house. Mr. Billip is farming the whole section, and he has good buildings, but I would not consider them the best

2669 buildings in the valley. A better picture might have been taken of the buildings but it is a good picture of the whole place.

The legend (Note hog in the foreground, rarely seen on the Laramie Plains) placed on Picture No. 123 was not gotten up by me. It happened that this was the only picture we got of a hog. The legend relative to pictures 133 and 136 as follows: "Note: The pictures on this page show usual appearance of most of Pioneer and Fischer canal areas," was put on in the State Engineer's
2670 office, and it is true. I would not say that the land shown in these four pictures is fairly representative of the larger part of the irrigated area under the Pioneer Canal, but representative of the area under that canal in that particular vicinity from the Grable ranch through the bluff to the west. The land irrigated from the Fischer ditch is supposed to be shown in one of these pictures, but it is cloudy. All four of these pictures are poor prints. It is not apparent from the pictures that the land is irrigated although such is the fact. I did not take pictures numbered 145, 146, 147, 151, 154, 158, 167, or 176, and know nothing about the legends on them.

2672 I did not take picture No. 177 although I recall the water flowing onto the road as shown in this picture. I did not take picture 181, but I know that the potatoes were frostbitten on the night of July 30. I could not say, however, that they were killed, and do not know anything else about the frost damage at that place. I did not take pictures numbered 186, 191, 192, 193, 194, 195 or 196, and know nothing about the legends attached to them. I took picture No. 201 and the legends should show that the buildings were unoccupied. Somebody may have been using the ranch. I took picture No. 211, but am not responsible for that portion of the notation relative to the freezing of potatoes and the freezing of the ground. I believe Mr. Woodhall made up this notation. I took picture No. 215. By the notation on this picture note that the buildings were vacant, not that the ranch was not in use. I did not take pictures 224, 227, 229, 231 or 243. I did not take any of the pictures of headgates and diversion works upon the Little Laramie River, shown in Exhibit 115.

2674 Where our plane table survey covered only a part of a section we covered the balance of the section by reconnaissance and placed the whole section upon our maps, photographic copies of which are in Exhibit 114. In the plane table survey we used a plane table with a telescope instrument called an alidade, having a magnetic needle. We got our north and south lines from the section lines, sometimes setting up our table between the section lines, however. I do not know whether in any case any effort was made to establish an independent meridian by either solar or siderial observations. The classification of pasture lands where used in connection with the Big Laramie Valley was not intended to segregate unirrigated from irrigated lands, but upon the Little Laramie River
2675 it was. Upon the Big Laramie River irrigated pasture land had been classified as pasture land. The tabulation of acreages which I have made includes all land irrigated in 1913 above Two Rivers on the main stream, together with some on Sand Creek, Soldier Creek, and Willow Creek. I have not checked my descriptions with the plats in order to verify the acreage.

2676 On the Big Laramie River we did not attempt to differentiate between meadow land and irrigated pasture land, but on the Little Laramie River this was done. Ordinarily where a field was partly cut and partly pasture land we classified it as meadow land, but in some cases where the pasture portion consisted of sage brush which could not possibly be cut over, it was classified as pasture land. The sub-classification of meadow land was based upon my judgment and observation from what I saw on the land at the time. I believe that I was able to make this classification properly at the time of year the survey was made.

2677 By permanent diversion structures I mean concrete or masonry structures. Wooden structures are not permanent as they need frequent replacement, but they are as efficient as concrete structures so long as they last. I cannot say that there was any dam at the headgate of the King Ditch at any time during the year. There was none there when I examined it, but water was flowing into the ditch which is practically on a level with the river, so that without any dam water will at all seasons flow into the ditch. The Bush and Holliday Ditch had no dam and got no water in 1913. The result of having no diversion dam is to prevent the securing of water when the river is low, the water flowing down the river to other appropriators. The lack of a dam does not lead to a waste of water. There were not very many ditches upon the Big Laramie River which were unable to get water in 1913 or which were short in their supply, but I paid no particular attention to this latter feature. I at-

2678 tended the taking of evidence in this case at Laramie in August and September, 1913. I believe I was present pretty near all the time evidence was being taken. I was not investigating in the public offices at Cheyenne any time prior to November, 1913, and was not at Wheatland. About the end of August or the first part of September I spent a part of two or three days in the assessor's office at Laramie.

2679 I was in the same neighborhood as the party doing the plane table work practically all the time, and the first month or six weeks I was actually with the party. During this period they made a survey of the upper part of the valley, including the Riverside ranch and the lands as far north as the county road. I

2680 examined the country lying north of the county road myself, but made no survey of it. The field notes were made by Mr. Woodhall, and from them I made practically all of the computations of area. We did not work together in this matter. Each of us made some of the classifications, my classification covering the territory from a point near the east boundary of Range 75 through the Riverside ranch.

2681 I had nothing to do with the actual drawing of the plats from which the photographs were taken, Mr. Woodhall making the rough draft and the draftsman completing this work. Some of the legends upon the photographs were made by me and some about which you have inquired were not. At the time the photographs were taken I made a memorandum of the number, the date, the location, and whether the house or building was vacant. I do

not believe that I could find this memorandum now and I have no copy of it.

2682 With reference to Section 1 shown upon Sheet No. 6 of the plane table survey, the lands lying north of the original King Ditch are designated as pasture land. They are under the ditch, but whether irrigated or not I do not know, and the designation is not intended to show anything with reference to the fact of irrigation. Upon those plats relative to the lands upon the Little Laramie River, however, I believe that where the pasture land is irrigated it is designated as "irrigated pasture." With respect to the lands upon the Big Laramie River, however, the term "pasture" gives no indication of the land relative to whether the same is irrigated.

2683 The 27 acre area south of the King Ditch designated as "old plowed ground" was broken up but was not in crop in 1913. The tract to the south designated "pasture--greasewood" had tall greasewood upon it, and so far as I know neither this tract nor that designated "old plowed ground" were irrigated from the King Highline Ditch in 1913, nor rom any other source. I visited this place only once, in June or the first part of July.

Section 6, shown upon the same sheet No. 6, is all pasture land with more or less greasewood upon it, and is all of the same

2684 general character. Part of the section was under the King Ditch, but I do not know whether any of it was irrigated in 1913. I made but the one visit to this section also. The same statement is true relative to Section 5 shown on the same sheet, which is likewise pasture land covered with greasewood, and I do not know whether any of it was irrigated in 1913.

Section 34 shown upon sheet 3 of the plane table survey consists of about three-quarters of meadow land and about one quarter of pasture land, the meadow land being that which was cut over for hay. Mr. Woodhall can testify better than I relative to

2685 the classification of the land in this section. I cannot state how much if any of the section was irrigated in 1913. Five hundred acres of the land in Section 35 shown on the same sheet No. 3 is meadow land, and the balance is pasture land. The determination of the particular area in each classification was made by Mr. Woodhall. I have been on the land more than once only as I have travelled along the road through it. I do not know how much of it was irrigated in 1913 or any prior year. My knowledge with respect to the classification and character of the lands in the Riverside ranch shown upon the plane table survey sheets is similar to my knowledge of the sections already referred to. The land in Section 22 marked in the name of E. A. Watson and lying north of the county road and shown on Sheet 2 of the plane table survey, was examined by me but not surveyed by the party, and I furnished the information upon which the map was made. I did not

2687 measure or step off the various distances, and had no instrument, but merely estimated the various acreages from the land lines and was only over that part of the land east of the ditch.

The ditch marked "Pioneer Ditch Lateral" crossing the county road three times in Section 28, does not stop on the point indicated on the plat, but runs to the northeast some place. I do not know how far it extends or whether the Watson land is irrigated from it, nor whether it extends down into Section 18 shown on Sheet
2688 No. 4 of the plane table survey, although there is a lateral upon that land. I furnished the data upon which that part of the area shown on Sheet No. 4 lying north of the county road was mapped. I obtained my information relative to Section 18 in this area from Mr. Havenek and Mr. Larsen, the owners of the land, who gave me the acreages. I did not go over the land which
2689 can be seen from the road. In a general way my information relative to all of the land north of the county road which is not included in the plane table survey was gained in the same way as my information relative to the sections already discussed and was intended as an approximation, only. I gave Wyoming the benefit of the doubt and I think my figures are a little higher than those of Mr. Meeker.

Cross-examination by Mr. John D. Clark:

I was able to tell from my examination whether the land had been irrigated for a number of years or had been placed under irrigation within recent years, and found that some areas were brought under irrigation recently. I could see that the area under irrigation was being increased a little, as there is always a gradual extension of irrigation. I am not familiar enough with that area to state whether the increase is more rapid than in other areas or not. There are lands lying under the constructed ditches which have not yet been irrigated, and I believe this is true of all of the ditches examined by me. Most of the bottom land has been irrigated, but there are extensive areas lying under the ditches on the higher benches which have not been irrigated as yet. I would not attempt to estimate how extensive an area of the lands lying under the constructed ditches have not yet been irrigated it is a very considerable amount. There are also lands which may be irrigated from these same ditches through the extension of them, as is true in almost any irrigated country. As is also true in any irrigated country I observed that there had been extensions from time to time of various ditches since their original construction.

Most of the ditches which I examined along the Big Laramie River are river bottom ditches as distinguished from high line ditches. The Pioneer Canal probably carries water to the
2691 most distant point from the river and this is probably six or eight miles, and the water is not carried over any minor watersheds by any of the ditches. Aside from the Pioneer Canal the King High Line, the Fischer, the Last Chance and the Parker ditches, all of the ditches from the river are river bottom ditches and most of them are only a few miles in length. I was never in the Wheatland area and so far as I gnow the State of Colorado has made no survey or reconnaissance of the lands in that district.

2691 Redirect examination by Mr. Fred Farrar:

Whether or not wooden structures are as permanent as those I have described, depends upon conditions and the way they are constructed. Some of wooden structures I found on Laramie river and which are shown in photographs, Exhibit 115, are as efficient as concrete. I refer to those in good repair. Some of them are not in good repair. Photographs show condition fairly well.

Lack of diversion works prompts people to complain of shortage when they could have obtained water simply by putting in diversion dam. Lack of proper diversion works might result in water passing ditch and whether or not it was wasted would depend upon circumstances below.

Photographs contained in Exhibit 116 were designed solely to show improvements and character of country, vegetation or lack of vegetation and verdure or lack of verdure. If in taking a
2693 picture a house is shown in background, it was not intended to slight that house.

In one or two instances, concerning which I was cross-examined, I testified to having made reconnaissance to north of county road running up and down Laramie Valley southwesterly from Laramie. Reason for reconnaissance was that plane table survey ended at the road, so far as particular plats concerning which I was interrogated is concerned. I filled out parts of sections above road by personal reconnaissance. Where section lines are truly defined and also subdivisions, you can make fairly accurate visual survey of the country, and determine matters with fair accuracy. That is the sort of survey Mr. Ralph I. Meeker, witness for Wyoming, made in this case. He made it much faster. He went by automobile. I find that I gave a little higher acreage in crops than he did. I was liberal. I gave Wyoming the benefit of the doubt in every case.

I assumed that officials of Wyoming exercised some care and accuracy in laying out the land and therefore did not determine original solar meridians. If Wyoming surveys are at fault, it may be that some of my surveys are a little bit off. Titles to pictures were made under general information gathered by me. I vouch for titles of these pictures of the originals where I have knowledge of field covered by photographs. I did not take all of photographs. Mr. Woodhall took a few.

There is considerable land under the Pioneer Canal which was not irrigated. Most of land under river bottom ditches has been irrigated. If Pioneer Canal was constructed in 1879, there has been opportunity for irrigation of those lands since that date. When I stated that all the canals except King High Line, Fischer, Parker and Pioneer, and possibly one or two others, are bottom ditcher, I did not include the new ditches now under construction leading from
2695 Lake Hattie and Lake James, and the like, I had in mind ditches to which I had testified that were on river bottom.

Water from Big Laramie River, taken out by Pioneer Ditch or Lake Hattie Inlet, is taken out of Lake Hattie and carried around over intervening divide and dumped into Big Basin on Little Lara-

mie River drainage. I understand Stewart Canal is surveyed and to be constructed for bringing of water from Little Laramie River over intervening divide and into Big Laramie River side. It is not as yet constructed. Am not familiar with Bellamy and Lobac Canals. In referring to the taking of water from Lake Hattie and discharging it into Big Basin, I referred to use of North Canal of Lake Hattie System.

Attention is called to legend on front of album, Exhibit 115, "This album should be considered in connection with testimony of Emmett C. McAnelly and George P. Woodhall". "It contains photographs taken during summer and autumn of 1913, by above named engineers, and contains photographs of most of diversion works used for diversion of water from Big Laramie and Little Laramie Rivers in Wyoming."

2696 "It is intended to illustrate the character of the structures used at heads of canals on above streams, and also their adaptability for purposes constructed, as well as care or lack of care in use."

"Particular attention is called to primitive character of all except the most recent structures.

"Photos appear of all principal diversions works. Only small and insignificant diversions works have been omitted, and particular attention was given to obtaining photographs of best works on streams."

"Owing to the fact that a number of diversions by small ditches (especially on Little Laramie) were concealed by grass and underbrush, it was impossible to obtain photographs showing condition of structures. However, photographs of the structures that are visible, are representative of those that are omitted."

This legend is correct statement so far as it contains the statement of facts.

The following legend appearing at the beginning of album, Defendants' Exhibit 116, containing pictures of ranches and improvements on Laramie Plains region:—

"This album is to be considered in connection with the testimony of Emmett C. McAnnelly, and Geo. C. Woodhall.

"It contains (with but few exceptions) photographs of all of the ranch and other buildings and improvements (exclusive of Laramie) on the Laramie Plains region of both the Big Laramie and Little Laramie Rivers in Wyoming, above their junction at Two Rivers, and all buildings below Two Rivers for six miles."

2697 "The photos also show the general uncultivated conditions of the lands of both valleys, most of which are used for grazing or growing native hay."

"Photos are arranged by government subdivisions, rather than by stream areas, and may be located by referring to annexed map."

"Several photos of the same ranch appear in a number of instances, notably:—Photos No. 193,4-5-6 and 7, the Perigal Ranch, and Nos. 199-203-7 and 8, the Hart Ranch."

"Date on which each photo was taken appears on bottom. Numbers refer to plat and are for better identification."

"The photos were taken by Emmert C. McAnelly, Deputy State

Engineer of Colorado, and George P. Woodhall, Colorado Georgrapher, during progress of their detailed surveys and observations on the Laramie Plains of Wyoming, in summers and autumn of 1913. Attention is particularly called to the character of the soil, vegetation and improvements on each picture, also general absence of trees, unhomelike character of improvements and their similarity to improvements general in stock-raising countries, where little effort is made towards establishing permanent and attractive homes."

"Compare this album with those of conditions under the Larimer County Canal and the Larimer and Weld Canal (Eaton Ditch in Larimer and Weld counties, in Colorado)".

That legend, so far as it purports to be statement of facts, is true.

In response to questions directed to me on cross-examination tending toward inference that I was not in complete touch with survey made by my party, would state that the survey was made
2698 under my direction. The making of investigations and general supervision of all the work was in my charge. Everything was done under my personal direction. At times I had 6 or 7 men in my party. In making plane table survey, one man operates instrument. We had three rod men in field. Rest of men are scattered at various points desired in making the observations. Men may be scattered out over radius of ½ to ¾ of mile. Instrument man sends out rod men. He sends them to different points. He trains instrument and makes his readings on rods at these different points. From these readings and directions, he makes his plat right in field.

Concerning question referring to county road running up and down Laramie Valley as being turn-pike, will say, that I have always understood that turn-pike road was an macadam road. This road is not macadamized. I took counsel to mean a graded road. It was natural material. This road had excavations on each side with materials thrown up in center. This was true for part of way. At other places it was not true. It was crowned at places with nat-
2699 ural material. It is graded for probably 12 or 13 miles west of Laramie and then in patches from there up. My survey covered about 60 linear miles on both streams. There are not many of these graded roads on Laramie Plains, aside from this one. The roads are such they don't need much grading, owing to natural road material. It is a gravel formation.

Houses and improvements represent in album, Defendants' Exhibit 116, except in district immediately adjoining Laramie on the West, are from ½ mile to 3 miles apart in places. These improvements are not close together except in vicinity of Laramie. It is a fact that traveling along main highways in Laramie Plains, with exception of country lying along river above city of Laramie, one may go for miles at times without passing a house. There is none of improved district more than three or four miles from main road, except on high bench land. There are very few houses on that. On the road
2700 from Laramie to Two Rivers, on the west side, it is about three or four miles between houses. These plats, so far as I know, show location of houses correctly. They do on area surveyed. The

map in front of Exhibit 116 shows houses by numbers on map and with reference to number of pictures.

2700 Recross-examination by Mr. N. E. Corthell:

The radius worked over by the rodmen in open country was not to exceed three quarters of a mile from the instrument, and they did not work often to that distance while I was present. I could
2701 not say what the average distance at which they worked was. The wind interfered considerably with our work, but in spite of adverse conditions we succeeded in completing that work shown on the plats. I could not say how much time we lost on that account. In a country where the wind blows almost constantly, and is cold and chilly, it is rather difficult to do this kind of work.

2701 Redirect examination by Mr. Fred Farrar:

Mr. Farrar: I desire to assure counsel for Wyoming that these pictures, so far as could be done, were taken with every degree of fairness. You will understand that cost of this survey and making pictures, all of which was done, as far — field work was concerned, in enemy's country, was quite a task and I was unable to afford expense of sending professional photographer with party. Any imperfections in pictures are due not to any intent but to fact that persons who took them were engineers and not professional photographers.

2702 Witness continuing: Map in Exhibit 116, upon which number of pictures appear, is U. S. Geological Survey Topographical Sheet. On this topographical sheet houses are represented by small dots. Houses as represented on this map, as prepared for U. S. Geological survey, are fairly correct. They are houses that were there at that time, that is, in 1908, when map was made. I found houses there that are not noted on map. I have photographs of them.

GEORGE P. WOODHALL.

2703 Direct examination by Mr. Delph E. Carpenter:

Associated with State Engineer of Colorado at Denver. Civil engineer. Graduate of University of Missouri, department of engineering. Have Bachelor of Science degree and degrees in mining engineering and metallurgy. Engaged in practice of profession continuously from time graduated thirteen years ago. I worked with Edwin E. Baker, an irrigation engineer at Greeley, Colorado, before graduating from school. His specialty is irrigation work. He devotes his time exclusively to that branch. Received part of my education in Greeley, attending school in that city. I was
2704 identified in engineering capacity with Lost River project in Idaho and also with project with the Minidoka and Southwestern Railroad in Idaho. Was assistant engineer with Harriman

lines for five years, having headquarters in Salt Lake City. During that time came constantly in contact with irrigation engineering and construction. Was employed specifically to handle that end of the work, being sent out on investigations on irrigation projects and reported to chief engineer at Salt Lake and my reports to him were transmitted to General Manager Bancroft and to John Krutchnitt, Traffic Manager of all Harriman Lines. Object of reports was to consider advisibility of building feeders or branch lines of railroad and whether or not same were warranted. During that time did a great deal of work in reconnaissance. On all projects on which reports were made, it was necessary to make estimate of cost and the returns that would accrue to road in next 5 or 10 years in matter of freight. Went also into possible passenger traffic. I had occasion to travel over states of Idaho and Montana. This engineering department embraced territory of Nevada, Utah, Idaho, part of Oregon (Cascade Range) also Montana and Wyoming as far east as Green River. In this connection I traveled over country and visited practically every irigation project in that territory.

During 1913 was identified with plane table survey in this case, being in field during entire summer, starting in May and ending in December. Was engaged in Laramie Plains area from Woods Landing down stream along Big Laramie River to point east of Bosler, and on Little Laramie River from Fillmore Station to Two Rivers, Wyoming. It is about 50 miles from Woods Landing down to Bosler. It is about 25 miles from Fillmore to Two Rivers.

2705 Emmet C. McAnelly was my immediate chief. From time to time I took instructions directly from state engineer of Colorado. My instructions were very brief. I was told to go out and get actual conditions as they existed. I was told to map the work by plane table. Mr. McAnelly was with me continuously for a few weeks and after that he was with me from time to time.

2706 I did all plane table work that was done on survey and at same time took notes and observations with regard to crops and various physical characteristics that were evident on the ground. I observed irrigation systems generally as one of physical characteristics. Observed system of diversion and use of water on both Big and Little Laramie Rivers for irrigation. Not all the plane table work done by me was compiled in map form. Work on uper portion of Little Laramie Valley from Alsop ranch upward was platted.

2707 Defendants' Exhibit 114 represents all plane table work on Big Laramie River Valley and on Little Laramie Valley as far as it was mapped. It goes to Alsop ranch and includes the same. This shows all general physical structures that appear in this territory and also nature of crops and grasses grown. Elevations were taken only in connection with Government elevations previously established by United States Geological Survey. In most cases these elevations are noted on sheets. Each table sheet includes 6 sections of land and there are 39 sheets in all.

Survey party consisted of 7 members. There were 3, sometimes 4, rodmen working from instrument. There was a draftsman, a

cook, an instrument man and chief of the party. We kept full camp equipment in field. Established our camps where it was most convenient for work, living in tents. We had team and wagon to go to and from work. Main difficulty encountered in surveying was prevalence of strong winds that sweep over that region. There were several instances where it was necessary to give up work for day on account of strong wind that was blowing. This was true during months of June and July, when wind was stronger than *on* August. June is really spring in that area, especially in upper end of plains; snow is leaving ground; grass is starting to grow. It was noticeable that when days were quiet amount of work accomplished by party was nearly double. Wind prevailed at least three-fourths of time while we were there. Just before going to work on Laramie Plains was engaged in work in vicinity of Denver, and then we went up there and established a camp and the first two weeks cold was very noticeable between the two localities. Wind came from snow fields on Continental Divide of Rocky Mountains, of which Medicine Bow Range is part. Prevailing winds were always from these snow mountains and very chilly.

2710 After plotting Bosler sheet took party and worked on Little Laramie River. Closed full party work middle of September. After that time we ran plane table up valley as far as Fillmore, using one instrument man and one rod man. Did not presume to map this last area. Did make survey of all land included in that valley under irrigation by accurate measurements. None of it was estimated.

Did not attempt to plat town of Laramie on our Sheet No. 22. The only indication appearing on that sheet is circle showing location of town.

On Sheet 3 of Exhibit 114 Caldwell Lake, body of water of approximately 160 acres of water surface, was omitted from the plat. It is on southerly part of Hoge and Haley Ditch area, and should appear in Sec. 27, Tp. 14 N. R. 75 W. It was surveyed with plane table in connection with the rest of survey and simply omitted on transferring from original sheet to tracing. It was error of

2711 draughtsman. In this survey the area covered by ditches, rivers and small ponds was not deducted from the acreage classified but *were* considered as a part of them. Several small ponds do not apear on the sheets, particularly so near the Riverside gate where there were two ponds. There are various other ponds down through entire area similar in extent to those on Riverside ranch which are not shown on the sheets.

2712 Classification of native hay and meadow lands, Exhibit 114, is as follows: First class meadows are those that will cut ½ ton of native hay per acre or better; second class meadows are those that will cut less than ½ ton of hay per acre, and third class meadows are those that show better than natural growth of grass, but not cut for hay.

I have been present during some of the testimony in this case. Have heard counsel for plaintiff and others classify lands as irrigated

pasturage. Third class meadows on my sheets are same as irrigated pasturage.

Little Laramie River has same classification as Big Laramie River, with exception of third class meadow. On Little Laramie third class meadow has been designated as irrigated pasture. This change of designation for this classification of irrigated meadow was due to the fact that Wyoming was so classifying their lands, and Colorado wished to have uniform classification prevail.

2713 Third class meadow on sheets 1 to 39 inclusive of Exhibit 114, is synonomous with irrigated pasture.

We did not detail, survey work of irrigated lands on Sand Creek other than that noted on Sheets 8, 9, 11, 12, 13 and 17 of Exhibit 114. There was no attempt to determine acreage irrigated on Soldier Creek, but on Five Mile Creek there is included certain amount of irrigated land as indicated by Sheet No. 20, covering lower extremity of that stream.

Various crops and native hay growing on land covered by plane table survey are illustrated on sheets of Exhibit 114 by means of symbols. Such is also the case with certain physical structures, such as telephone lines, fences and buildings. Specific symbols used are those for township, section and subdivision lines, barbed wire fences and pole fences, telephone lines, grain, alfalfa, potatoes, plowed ground, meadow land, pasture land, grease-wood, bluffs, trees and roads. Grain is included under one symbol, but individual sheets show kind of grain cultivated. For example, field of oats will be noted by symbol for grain and word "oats." Same is true of other grain. Meadow land is indicated by meadow land symbol and then classification is placed in each tract. Pasture land has a symbol of its own. It is same as grazing land and indicates land with natural growth of grass. In some places pasture land was in fact included in meadows, although not noted on sheets. It occurs largely in the third-class meadows or in irrigated pasturage. What I designate on the sheets as pasture land was unirrigated.

As a matter of additional notation, there appears for example on Sheet No. 5 of Exhibit 114 field wherein grain is not only designated but also the height of the grain, and the date. The oat field designated on Section 31 on Sheet No. 5 of Exhibit 114, designation is "oats 12 inches high on June 26, 1913." For further illustration on Sheet No. 11 of Exhibit 114, the alfalfa notation appearing in the northern portion of Section 31 reads, "Alfalfa—first cutting off, second cutting three inches high on July 23, 1913." Throughout these sheets, similar notations were made from time to time concerning crop conditions ascertained as we were passing along. These observations and details were noted by me.

Names of various owners appearing on sheets on Exhibit 114, were learned during the time of the survey. We were in community of our opponents and before making surveys of any tract we went to house or ranch closest to land and asked permission to run the survey over it, and in connection with that we inquired names and obtained other information from parties at various houses. We were refused permission to enter some premises, for illustration, man in

charge of Riverside Ranch refused permission to enter that property and the survey party was held up some little time on account of refusal. It was finally found necessary to take matter up with company controlling the property and obtain permission from headquarters at Denver before we could make the survey. This was done by long distance phone through State Engineer, Mr. John E. Field, at Denver.

We note topography on these sheets to some degree by our symbol for bluffs. Also by dotted lines for edges of distinct bluffs bordering table lands. For example, on Sheet 4, Exhibit 114, line of short dashes, entitled "edge of bluff" indicates point where in this specific sheet meadow lands end as shown on plat. Rise of land thus indicated on Sheet 4, is the rise of land of the bench along the main travelled road between Laramie City and Woods Landing. On same sheet main traveled road is indicated by double dash line and fence on each side of it. Telephone line is shown on north and west side of road and indicated by symbols explained on index sheet.

Where tract is indicated as covered by grease-wood I refer to a tough, woody plant, a good deal after the order of sage brush, only more fibrous, and tougher. Grease-wood has a greater growth than sage brush. It usually thrives upon alkali soil and is on a clay base. Grease-wood land is not regarded as agricultural land. The largest areas of grease-wood land observed on the survey were on the southwest side of Laramie River in neighborhood of Riverside Home Ranch, above mouth of Sand Creek. Country on which grease-wood grows is all more or less of a pitted character. Winds blow the dirt in the space between the roots of the grease-wood and form hummocks. Grease-wood continually growing out of soil drifted around base forms pits and sometimes as deep as four feet, and five or six feet wide between the hummocks. This was particularly called to my attention in hunting section corners on the southeast side of Laramie River in the neighborhood of Riverside Ranch. These greasewood lands observed on this ranch would not be classified as irrigated lands in any sense of the term. They are not capable of being irrigated without being grubbed and leveled off on account of pits and hummocks that are characteristic of the surface in the locality mentioned. We nevertheless gave plaintiff benefit of many of these grease-wood hummocks occurring in the meadow lands without noting and deducting them on plats. Small areas such as 8 or 10 acres, one piece occurring in a section or quarter section, was not specifically noted but was included in the meadow lands.

These small areas are not in the general grease-wood area.

2718 Places where the grease-wood symbol appears indicates that the predominating feature is grease-wood and is not irrigated land. Sheet 6, Exhibit 114 shows one of the grease-wood areas.

The grease-wood bush or shrub grows as tall as a man. It has tough fibrous growth, similar to the growth of the gooseberry or raspberry or currant bush, but the wood is tougher and stems are thicker. It is not a plant that the mowing machine can cut. It would take a hatchet to cut those grease-wood stems. The greater portion of the area shown on Sheet 6 is designated as grease-wood

land, because this land is entirely covered with grease-wood. This land is pitted with little wind pits between the shrubbery as I have described. It is not agricultural land and could not be used
2720 for agricultural purposes. Throughout Exhibit 114, wherever we have desired to designate an item for which we have no symbol, we used words.

Acreage noted on plats in Exhibit 114 were ascertained by accurate survey. They are the true acreages. Where land is designated as plowed, it means that the ground was turned over in the place designated. It was not in crop. Most of the acreage appearing on the plats of Exhibit 114 is of land that has not been turned over or plowed.

Notation "Fox Tail Meadow" appearing on Sheet 19, containing index to plats of Wyoming Experiment Station, indicates that the meadow was covered with fox tail grass. It resembles barley
2721 its growth is not as high as barley. *Its growth is not as high as barley.* It is not good for hay. Fox tail gets into the jaws of the stock, and if fed continuously will cause ulceration and stock will not eat it. My estimate of the acreage nevertheless gave Wyoming the benefit of fox tail meadows as irrigated agricultural land. It is included as meadow. Unless fox tail was most predominating feature in meadows, it was not mentioned. There are a good many meadows that have fox tail where no notation is made of it on plats.

A number of sheets show lands lying apparently beyond limits of actual plane table survey. For illustration: sheet 24 where Sections 31, 6 and 33 are all designated as "All this section is pasture." I ran over the ground with my instruments. The physical feature was that all of the ground was in pasture on bench lands. Survey was not as accurate as rest of survey next to railroad in this specific sheet. It refers to lands that are grazing and not irrigated
2722 by artificial means. That is not same character of grazing lands prevailing throughout arid region of west: Growth on these bench lands is more sparse than at lower altitude. Grazing land in Weld County, Colorado, has nearly 50% more vegetation than would be case on Laramie Plains region. Lower elevations are generally marked by more luxuriant growth of grass. Where elevation in Weld County, Colorado, is same as Laramie Plains, growth would be practically same. Bench lands above irrigation between Big and Little Laramie Rivers is not shown on sheets. That is arid pasture land, ordinary grazing land. It never has been
2723 irrigated.

The plane table survey extended up to county road on north side of Big Laramie River from point of beginning to range line between ranges 74 and 75, then extending north, covering all irrigated area under ditch from that point down river. Above that point there are irrigated lands north of county road that are not on sheets. Mr. McAnelly checked that land. I did not cover that work. That is the land referred to. That is the land referred to as covered by reconnoissance by McAnelly in his testimony. It was

strip about 2 or 2½ miles wide, parallel to Big Laramie River, above plane table survey, extending from Sodergreens Lake and toe of Sheep Mountain easterly to range line between Ranges 74 and 75 West. About 12 miles. Not much of that area can be considered as irrigated west of Sodergreens Lake. I have been over ground but never made any estimate of average there. Sodergreens Lake is north of county road in Township 14, N. R. 76 W., and is in portion of sections 21 and 28. It is point where Lake Hattie Inlet leaves line of Pioneer Ditch and runs westerly into Lake Hattie. Outside of area described, north of county road, we covered all irrigated lands on Laramie River lying below Sodergreen's and above Two Rivers on west side of stream. Survey extends all over lands that were irrigated from Big Laramie on south and east sides and also included some lands irrigated from Sand Creek. We covered
all lands irrigated by diversions from Big Laramie River,
2725 taking water on the south and east side of stream. From
this survey will be able to give acreage of all irrigated lands under each canal taking water from Big Laramie below Sodergreen's ranch. Acreage of land covered by McAnelly reconnoissance is practically the same acreage as that obtained by Wyoming engineer, and by adding that the total acreage in valley can be ascertained in connection with plane table acreage. I refer to figures already given by Engineer R. I. Meeker as well as those furnished by McAnelly.

Made photographs during survey. Taken during progress of work from day to day, and all conditions, both favorable and adverse. Defendants' Exhibit 115 contains some photographs made by me. I made major portion of pictures taken from Hart ranch down stream on Big Laramie and all the photographs taken on Little Laramie. Little Laramie photographs appearing in fore part of album, represent diversion works in Little Laramie Valley and includes all diversion works of any magnitude and a great part of the smaller ditches but not all of them. The little ditches have no headgates, and many of them are simply gashes in river bank of a narrow width and short length, and observer who did not know these were called ditches would be unable to ascertain whether it was an outlet or an inlet from river, or whether portions were return channels for flood waters from meadows. They were not dignified by headgates. I was unable to tell in many cases where the heads of the smaller ditches were. In connection with taking these pictures on Little Laramie River, I had as a matter of information, a map compiled by the Department of Agriculture at Washington, which purported to show all ditches with water rights from Laramie River and I used this in determining where ditches were located and even with the aid of this map it was hard to tell sometimes. These gashes in river bank were of such a number that it was impossible to tell whether they were to let water into or out of the river, unless water was actually running at the time. I did take photographs of all substantial, visible diversion works on Little Laramie as far as I
could observe them. I obtained photographs of all good
2727 diversion works on that stream. Purpose was to get pictures
of all headgates on Little Laramie River that could be found,

and this purpose was followed in taking these photographs. If any are missing, they are insignificant and those that I did take are better than typical conditions of these poorer diversions.

Majority of pictures I took on Big Laramie were below Hart ranch. I obtained photographs of all diversions works of all ditches taking water from river below Hart ranch. Became familiar with diversion works between Hart Ranch and Sodergreen's Ranch on the Big Laramie during time was making survey. Photographs of these works appear in Album Exhibit 115. I believe every one of diversion works on Big Laramie River is in album because any that did not come out well a special trip was made back to get the picture. At least all better ones appear.

2728 Part of photographs appearing in Exhibit 116 were taken by me; those below Hart Ranch on Big Laramie and those on Little Laramie I took photographs of all of buildings and improvements on Little Laramie area. This album does not contain photographs of every set of buildings and improvements on irrigated area in Little Laramie below Filmore. There are six groups missing. They were taken but the weather was unfavorable, the pictures being taken during snowstorms that lasted between two and three days. Storms in nature of little snow flurries, and photographs that are missing are of same character as those that are shown. Missing photographs are those of Joe Clark Ranch on Bell Estate, and Knudson's place, and the Irwin Ranch. Photographs appear in Exhibit 116 of all buildings and improvements on all property on Big Laramie River below Hart Ranch. I don't know that there are any missing views above Hart Ranch. My understanding is that every picture of improvements on Big Laramie River from time survey was started until it was finished was included in this album. I

2729 heard Mr. McAnelly's statement that he thought some of photographs were missing, but I went back after Mr. McAnelly had been there and took some more pictures. For all practical purposes Album 116 includes pictures of all buildings and improvements on irrigated areas of both Big and Little Laramie Rivers in Laramie Plains Region, down as far as the immediate vicinity of Bosler. Legends on these pictures were from knowledge obtained from actual inquiry while on survey. Made notes of information in engineering field book and saw Mr. McAnelly's notes with relation to pictures he took. Legends written below photographs in Exhibit 116 were written under my personal supervision. Also legend appearing on title page of album and the reading matter thereon. Same is true with relation to Exhibit 115. The lead pencil memorandum made by Mr. McAnelly in connection with these photographs, which was requested by counsel for plaintiff yesterday, was turned over to me in making the legends on various pictures and after I was through with — I put it into the waste basket. I suppose it went down where all waste paper goes. Legends under all

2730 pictures taken by Mr. McAnelly contain all information noted on these lead pencil pages. There was no picking out or curtailing of legends in the original notes. In some instances there appear some special designations in legends in addition to

matter contained in McAnelly notes. I have examined both of these albums after they were completed after legends were copied, and all statements contained within these albums are true to my knowledge. Title pages and legends in albums, Exhibits 115 and 116 were written in white ink under my surpervision by members of State Engineer's office of Colorado.

In taking photographs appearing in Exhibit 116, in addition to photographing mere improvements or buildings, pictures were taken with idea of showing surrounding physical features.
2731 Wherever photographs were taken, notation of date and other data was made.

Maps appearing on Exhibit- 115 and 116 were prepared in same manner as album under my personal direction. I used United States Geological Survey Topographic Sheet for territory embraced in the pictures.

These numbers indicate correctly location of various pictures appearing in each of these exhibits. One looking at photographs in either of these albums, Exhibit 115 or 116, cannot only ascertain location of scenes depicted in photograph by memoranda beneath picture, but also by referring to these maps in front of albums can obtain location by corresponding numbers appearing on map.
2732 Several duplications will be found in Exhibit 116 as noted in legend. Duplications are on better ranches from fact that better ranches have more buildings than poorer ranches, and in order to show them clearly we put on more than one picture. Album 116 conveys to mind a fair illustration of conditions appearing on Big and Little Laramie regions, when taken in conjunction with plane table plats. Everything is there. If there are missing numbers they are insignificant. In album Exhibit 115, number of photographs appear to have been taken when snow was on ground, for reason that last work was done in that locality when ground was covered with snow. Pictures were taken during tour down the river for that purpose. Taking of these photographs was delayed owing
2733 to fact that supply of films for kodak was entirely exhausted at Laramie.

While I was in Laramie Valley making this plane table survey and carrying on observations, noticed methods of irrigation practiced in that locality. Irrigation employed on meadows was by means of flooding Meadows are more or less cut up with sloughs and ground is, to certain extent, filled with small pockets Middle strip of Little Laramie Valley between its channels is full of knolls of quite an elevation. This is true to a lesser extent of all bottoms in both Valleys. There are knolls in meadows that are higher than surrounding ground. Water is turned on meadows in one large body and allowed to spread itself out in fan shape. Water floods all ground wherever it is turned out of ditch and extends possibly a quarter of a mile down stream over meadows where it is again collected by means of some little obstruction and again diverted in same way. This is continued on down valley. Result is that practically all water in whole ditch is utilized as a body of water and flows over ground. It is picked up at stated intervals and goes through same operation.

Little Laramie River is made up of several channels below Fil-
more Station. These channels are utilized in the flooding process
and take place of ditches. It is fact that during irrigation of hay
meadows the water of the Little Laramie is spread out over
2734 the whole valley. They put in manure dams with a few poles
and check flow of stream, flooding each side of obstruction.
The same is true in a measure of the methods of distribution of water
on Big Laramie. There are few men, appparently, engaged in water
distribution. At time I was at Riverside Ranch, which was during
the active irrigation for meadows, they stated that they had two
men on ranch looking after water, and this is a very extensive ranch.
There is no supervision of water after it comes out of ditches and is
spread over meadow. So depressions throughout these large areas
hold the water and it appears like whole valley is filled with water
with connecting necks of land between water surfaces.

Most of ditches on both Big and Little Laramie Rivers
2735 are so constructed that the bottom of the ditch is above the
level of the bottom of the river. The specific example I
have in mind is the Boughton Ditch. Inlet to Lake Hattie and
head works of the Pioneer Canal are so constructed they can divert
all of water in stream. They have dam that raises elevation of river
to elevation of ditch to get water. Is a good structure. Consequence
in times of low water in river, where ditches are of the higher or
two-story construction is that water cannot be taken down through
the ditches because it cannot be diverted. It would not be surprising,
in such a case, if one having land along these canals imagined that
he had a shortage of water. If they build the ditches so they are
above the water in the river they surely can't get water through
them. As another example of these high water ditches, I recall
the Bush and Holliday Ditch, owned entirely by Mr. Rick-
2736 ard. I was camped at his place. The level of the ditch was
above the level of the river, in the neighborhood of four or
five feet, and in 1913, bank was washed away in front of it, and
there was no adequate means in that year to take water down. He
made no effort to remedy ditch during season of 1913 up to time I
left, and that was more than half way through irrigation season.
It would not be surprising Mr. Rickard imagined he had a short-
age of water, under those conditions.

Biddick Canal is a little worse than Bush and Holliday Canal.
It was impossible to see the water above it as you stood below and
down stream. It would not be surprising if Mr. Biddick was unable
to get water in this ditch with such a structure or lack of struc-
ture.

2737 Method of diverting large quantities of water and turning
it loose on meadows is only practice used for meadow lands
in either Big or Little Laramie Valleys. If all water is taken out of
stream by man higher up the stream and turned out over his place,
consequence is that man down near mouth of stream in lower part
of valley has to wait his turn before waters get to him. It is not
surprising if he finds himself short of water under such conditions.
There is a great waste above.

I had conversation with Mr. Grant who was supervising water in 1913. He was Water Commissioner. I had interviews with residents of valley to ascertain what supervision had been maintained over water from these streams by state officials during previous years. There had not been any distribution of water, everybody took what they wanted and that is the case there today. I refer especially to these meadow lands. Every man had a little ditch out of the river, took all the water he wanted out of the ditch, all it would carry, and the rest went down the river.

2738 Water is put on meadows and run continuously until just before time to cut hay, when it is taken off, and after drying cutting progresses. The meadows are in condition of mire prior to time they are dried off. To take specific instance, I attempted to go by horseback over to Sand Creek bottom from Hutton Lake to Rickard's Ranch, where our camp was, and horse got mired and I could not get through. Had to turn around and make a detour of seven miles to point where Sand Creek flows into Laramie River and then go up on bench land to north of Laramie River to camp. A team attempted to cross valley in lower part of Riverside Ranch and they could not get across. Ground was of such consistency that it would not hold up weight of team and wagon. That condition prevailed throughout meadow regions or rivers bottoms. In irrigation of these meadow lands, practice seems to be for every man to take all the water he wants through his canal, run it continuously, and as long as he wants to, and let it take care of itself in the matter of distribution.

2739 Supervision of distribution of water is much closer in Cache la Poudre Valley. In this region there would be large number of men on an area the same size as Riverside to look after water, and to distribute it. In Cache la Poudre Valley they have more laterals and they don't flood whole valley from one end to other. They distribute water from laterals. Men stay with water and aid in its distribution. I have often seen them in Poudre Valley working nights at irrigation. I don't know a single instance in Laramie Plains of their irrigating at night. In Laramie Valley they use the same slovenly method of distribution on table lands above river bottoms where meadow is attempted to be cultivated. The same method prevails under Pioneer Canal. Water wastes and collects in ponds below the ground irrigated on these upper areas. These ponds are not utilized for irrigation. There is no outlet to them. Water stays there and evaporates. These ponds are numerous at the ends of laterals. This is generally true where water is applied to land situate on these table lands.

2740 There are two series of ponds on north side of Laramie River that seem to follow right down a straight line until it arrives at the bench just above river. There is wet land between and around these ponds. There is more or less wet lands around ponds that appear out on the bench. I don't know of a single instance in which means have been provided for utilizing this water thus standing on saturated ground or in these ponds. They have attempted no system of drainage whereby they could make beneficial use of water

thus wasted. Would say that as a whole this practice is pretty prevalent over the entire Pioneer area. This same method of careless handling of water prevails there.

On Little Laramie ditches run into ponds and there is no outlet. Some of these ditches are of considerable size. All large ditches waste into ponds. For example, the Hecht & Farrell. This ditch wastes into the lake on Sec. 17, Tp. 16 N. R. 75 W. There is no outlet ditch for distribution of that water from the pond. There
2741 are several small ponds that continue along there in chain, along low depression; but there is no outlet to them. That water thus discharged into those lakes is not used for irrigation.

Poverty Flat and Parker Ditches both waste into a big alkali lake in Big Basin. There is no outlet to that lake. Water level in this lake, this alkali lake, is about 75 feet below water level of either Big or Little Laramie rivers at the nearest point, and country between is at quite an elevation. The lake of upwards of one-half section area in bottom of Big Basin is fed by these waters thus wasted. Waters at lower end of Poverty Flat and Parker Ditches could be wasted back into rivers by means of other ditches with little effort by construction of waste ditch. There is absolutely no effort there to do so. It seems that main idea in wasting water there is to find convenient place to dump it when there is any waste to be turned away.

Observed so-called domestic use of water on Little Laramie River in December, 1913. There was water flowing in both Poverty Flat and Parker Ditches then. This flow was about three-fourths of the ditch full, and as weather had been cold, ice had been frozen on the ditch and they were carrying this head of water through ditch so as to have water reach lower end of ditch for stock purposes. The water all went down into the Big Basin, into the alkali lake. Absolutely no provision was made for taking this water back to the river from whence it came. That was the kind of domestic use I observed.

Snake Ditch wastes into pond in same manner on north side of Little Laramie river and waste water of Bellamy Ditch goes down into a pond. By Bellamy Ditch, I refer to ditch that runs down past the Mandel post office, sometimes called the Loback Ditch. Those ponds are located along through tier of sections, through ranges 76 and 77 West and Township 17 North.

2743 In none of these ditches thus carrying water for alleged domestic use for watering cattle, where large quantities of water were carried through winter months, are there any waste ditches, or any effort made to have water conveyed back to stream so as not to waste it.

Water running in so-called North Canal or outlet to Lake Hattie Reservoir of Laramie Water Company during 1913 wasted down slope into alkali lake in Big Basin from end of construction, being end of North Canal to Lake Hattie outlet. No effort was apparently made to return that supply of water to stream. This alkali lake is same receptacle that receives water of Poverty Flat and Parker Ditches. It is a mere evaporation basin. Ground between them is

high and there is no likelihood of underground current being
2744 able to seep through. Water in this lake is highly alkaline and that is reason lake is so named. Stock will not drink water from it.

Referring to Defendant's Exhibit 1, map attached to answer of corporate defendants in this case, will state that canal there noted as terminating immediately west of Laramie as North Canal now continues down valley further. It terminates near lake show on map as "Big Basin" and "Alkali Lake." At time map was made the end of canal was properly noted. Construction of this lower end extension is very recent. They have been working on that canal all during 1913 for extending ditch, I should judge from point shown on the map, Defendants' Exhibit 1. This waste of water from this Lake Hattie outlet down into this alkali hole which has no outlet,
2745 was going on summer and fall of 1913. I first noticed it about middle of July and water was running in ditch up to latter part of September. Saw it actually running into lake along middle of August and down until September.

This waste of water by Laramie Water Company could have been prevented by running the water to Big Laramie River by dropping it down in one of laterals that flow into Carroll Ditch, and then by that means into Laramie River. There was no apparent effort to thus save water for use of consumers below. If this waste had not been diverted through month of December, for example through Poverty Flat and Parker and other ditches and had not been run out in large quantities into these waste lakes but had been allowed to flow down stream, or had been allowed to run back to stream from lower ends of ditches, it would have gone into Big Laramie and been available for storage below. All of these diversions of which I have been speaking are above Wheatland Reservoir No. 2. There is no tail ditch at lower end of Pioneer Canal to the river. There is one extended in northerly direction to point west of Maynard ranch on the west side of Laramie Ditch that
2746 has been abandoned. There is drop from present end of Pioneer, locally known as Butler extension of Pioneer, about three or four feet below this tail ditch, where it runs down through gulley to right of way of Union Pacific railroad. Railroad makes provision to take this water from around its embankment, and they have to put pipe underneath their track and water is conveyed to other side. On other side there is alfalfa field of about 26.3 acres and after water irrigates that it flows into river. In this connection, it might be stated, that if tail ditch were used, water would flow into waste pond on southwest quarter Sec. 31, Tp. 17 N., R. 73 W. Outside this Butler Canal or ditch at lower end of Pioneer, I do not know of any other canal in valley that has anything resembling tail ditch, where excess waters are conveyed for any purpose through canal and being unused, returned to stream for benefit of other appropriators. I did not note any during my surveys.

Referring to Defendants' Exhibit 1, map attached to answer of corporate defendants, will state there are soda lakes in the north

end of Township 14, N., R. 75 W., and lake near center of
2747 Tp. 15, N., R. 74 W. These lakes are commonly known as Seven Mile Lakes. These specifically named are large lakes. There are a good many small lakes not shown on this map on account of scale. There is water standing in series of depressions indicated on map extending easterly from Lake Hattie towards Laramie and down to Seven Mile Lakes. They are used as waste lakes. Surface water from irrigation runs into these natural depressions which have no outlet. Soda Lakes are of large area. They are natural lakes. Seven Mile Lakes are natural depressions of considerable size. Other than little canal noted as Episcopal Ditch, leading from one of Seven Mile Lakes, there is no canal or outlet constructed from any of these Seven Mile or Soda Lakes or other depressions extending between Seven Mile Lakes and Lake Hattie. Episcopal Ditch ends in some old plowed ground. Don't remember whether it is in use at present. If in use it would afford an
2748 outlet for one of these lakes. There are number of smaller lakes not noted on maps. You cannot plat much closer than 175 feet on maps like U. S. Topographical Sheet of that region, so that lake has to be of quite a magnitude before it would appear on maps.

There is no liklihood of water discharged from Pioneer and flowing and accumulating in Seven Mile Lakes, ever returning to Big Laramie River. There are ponds on Hart Ranch on Section 1 and on Section 22, also on Section 21. These ponds are noted on my plane table survey, sheet 15. They are natural depressions, so situated that water wastes into them. They have no outlets and are below surrounding elevation.

2749 Caldwell Lake appearing on U. S. Topographic Sheet in Sec. 27, Tp. 14 N., R. 75 W., is waste water lake without any outlet. It covers about 180 acres. The Hoge and Haley and the King High Line Ditches run in that vicinity. These larger illustrations I have given are fair illustrations of process that takes place of accumulation of water in smaller basins all through irrigated land during time water is being allowed to distribute itself in manner indicated. They are fair illustrations of what takes place in smaller scale over area of the two rivers, during months when meadows are not being irrigated, but when there is water being run through canals and into ponds and lakes under claims of domestic use.

James Lake appears on topographic sheet of U. S. Geological Survey as a lake without an outlet. It originally was a waste lake. Recently that has been converted into a reservoir with an outlet whereby waters can be diverted to lands below it.

Condition of valleys of Big and Little Laramies being miry, so it will not hold up horse and rider, indicates that soil is
2750 saturated to such an extent that there is more water there than is needed. The same is true of the area between the line of lakes under Pioneer Canal of which I spoke. I refer to string of lakes from Lake Hattie down to Seven Mile Lakes. Same is true north and east of these lakes. You find these spots and tracts all

along that area. On Little Laramie there is saturated area extending as far down as Puls' Ranch, northeast of Millbrook Ranch. It extends distance of two miles. South of river there are lakes extending through tier of sections from center of Tp. 16 N., R. 76 W., easterly for about three miles.

Observed no attempt to drain any land anywhere.

2751 Obsedved crop conditions, not only on area on which I worked, but to some degree outside of that area wherever there was irrigation. Observed growth of alfalfa plant on fields I visited.

Alfalfa grew about 18 or 20 inches high before it was ready for first cutting and before it began to bloom. Observed patches of alfalfa on Laramie Plains as follows:

On Sodergreen ranch there was some alfalfa, the next patch below I believe was Mansfield's and Mountain View Ranch, (part of Fischer place), and the Hart Place. There was some alfalfa on Experiment Farm and some little on stockyard ranch. That is adjacent to suburban tract right west of Laramie on north.

July 7, 1913, first cutting of alfalfa on Hart Ranch.

2752 First cutting alfalfa on Grable or Mountain View Ranch practically same date.

September 18, 1913, second cutting alfalfa on Hart Ranch. Second cutting alfalfa Grable Ranch approximately same date. There was not much alfalfa on Agricultural College Experiment plate immediately west of Laramie, and I did not make special note of time of cutting. On Section 31 there is notation, alfalfa, second crop, 8 inches high, August 2, 1913. Another, 1.8 acres alfalfa one foot high in bloom August 2, 1913. The latter was evidently left for seeding purposes. Another, alfalfa 10 inches high, second crop, July 2, 1913. Another, August 2, 1913, alfalfa one foot high, second crop; alfalfa, second crop, August 3, 1913, one foot high. Alfalfa one foot high July 26, 1913, Alfalfa 8 inches high, second crop, August 2, 1913. Latter field is one that had been left for seed. It is only 2.3 acres. Another, alfalfa 3 inches high, second crop, July 29, 1913. These specific examples are tracts in Section 31. They indicate second growth at time I was working there.

Don't believe there was any second cutting of alfalfa

2753 on Little Laramie Valley. What I saw was standing there and used for pasture at time I left. One cutting had been taken and balance was used for pasturage. Alfalfa on Little Laramie was in small tracts.

Ascertained tonnage produced first cutting alfalfa. Notes I took were turned over to Mr. McAnelly and were all put in same place for reference and they are in his notes, and his deductions are from the joint labors of both of us. I checked his conclusions to ascertain whether or not my calculation would bring me to same tonnage estimate. We both worked out tonnage separately in order to have check one on another, using data before us.

2754 Observed notation of tonnage on hay stacks on Hart Ranch made by others than myself. Stacks on Hart Ranch were

numbered. Each was indicated by stake driven into ground opposite one end of stack and on some of these stakes were slips of paper with tonnage. I checked these notations with results obtained by Mr. McAnelly and me from measurement. They checked practically same. Variation was not to exceed 1/10 of ton.

Checked tonnage production alfalfa on field on south side of river. I suppose people on Hoge Ranch owned it. That was field given by Mr. McAnelly in his testimony. I checked observations
2755 with Mr. McAnelly as to that field also. He gave correct figures.

Largest field alfalfa in whole Laramie Plains region is on Hart Ranch. Next is Grable field. Made no tonnage checks on Sodergreen or Mansfield tracts.

Native hay tonnage on Little Laramie River at Bath place was measured by party consisting of Mr. John E. Field, State Engineer of Colorado, Mr. McAnelly and myself and owners of the place were asked if they had disposed of any of hay from ranches or whether any of it was in other stacks for season of 1913, and he stated it was all on the ground in the meadow. Statement was made to me by Mr. Bath himself in presence of Mr. John E. Field, State Engineer of Colorado, and Mr. McAnelly. That is same event of which Mr. McAnelly spoke of in his testimony. We measured stacks that
2756 were in field. I heard Mr. McAnelly testify as to tonnage ascertained. We figured that tonnage on ground before we left land. I figured individually and he figured the same way and we both got the same results. The result stated by him yesterday was correct. Six-tenths of a ton per acre.

Oats on Shaw Place in Blackburn Ranch on Little Laramie yielded for 1913 24 bushels per acre. Wheat produced 11 bushels per acre. Flax 8 bushels per acre. There were 19 acres of flax on whole Blackburn Ranch. Observed crops on this display ranch prior to time they were harvested. Crops had received entire attention of people living on place, as they were attempting to farm for a livelihood there. Consequently they devoted more time to raising
2757 their crops while in other places the oats were raised for consumption of animals of home ranch. Crops on this ranch were better than the average, there being considerable difference between crops raised on Blackburn and those raised on Ernest place. Latter place is southeast of Blackburn ranch on Little Laramie River.

On Big Laramie River, during 1913, Grable place produced 2200 bushels of oats. Do not remember acreage.

Average production oats on Blackburn ranch on Little Laramie River for 1913 was 12.6 bushels per acre in field of 63 acres. There were 793 bushels threshed.

2758 Did not see many hogs on Laramie Plains during survey. Did not observe over two or three dozen outside of Wyoming Experiment Station, on both the Big and Little Laramie areas. In almost every instance they were simply around ranch buildings, just two or three hogs for home consumption. 1910 census shows 343 hogs on Laramie River Basin and in whole of Albany County. Referring to picture 123 in Exhibit 116, will state that I placed

notation at bottom "Note hog in foreground, rarely seen in Laramie Plains." That is the fact. That is not hog raising country, they don't raise corn there, and there is no corn on the Wyoming Experiment Station tract. Season is too short for that character of crop. Hog industry necessitates raising corn or feeding of corn. They evidently do not in any way depend upon that industry in Laramie Plains.

Cattle, horses and sheep were live stock observed on Laramie Plains. Main use of horses in that vicinity is for tending cattle, and they all are of light weight and small size compared with those in farming communities where draft animals are required. They are more of broncho type than draft animal.

2759 Cattle raised are mostly for stock. They are not raised for dairy purposes. The dairying stock consists of a few head around Laramie to supply town with milk.

Referring to native hay on Bath place, which I stated we measured, will state that it was raised on a meadow which was some better than the average in the valley. Meadow was very level and there were no hummocks in it. Lands were cleared of sage brush and was practically all clear meadow throughout, which is not the case in a great many other places in the meadow land in the Laramie Valley.

Concerning production native hay 1913 as compared with 1912, will state that while talking with inhabitants of valley located on meadow valley, they advised me they were trying to get all hay they possibly could, because of prevailing good prices for hay sold on market in Kansas City and Denver, there being scarcity of hay crop in other localities. This was incentive for cutting as much hay as possible. They stated that their crop was better than

2760 during 1912.

In measuring native hay lands on Little Laramie Valley, we made plane table survey all way up to Fillmore. It was accurate. United States Government uses plane table on their boundary lines between Canada and the United States. It is generally used on work of the class I was doing. In checking out native hay meadows, was careful to follow meander of meadows and their edges. Margins go in and out and shots were taken at these points. I did not exclude from the meadow lands hummocks or little irregular tracts that were not really meadows. I included these within the meadows. I took outer boundaries and what was included inside was classed as meadow. As the result of these observations, ascertained definitely number of acres of meadow land in Little Laramie Valley. Exhibit 117 is tabulation of irrigated acreage in Little Laramie Valley during year 1913 as ascertained. It includes acreage between Fillmore and two Rivers, Wyoming.

2761 (Defendants' Exhibit 117, a tabulation of irrigated acreage in Little Laramie Valley, offered in evidence.)

Data appearing on Defendants' Exhibit 117 is obtained from figures made from actual measurements of that portion of Little Laramie River Valley between the Alsop Ranch and two Rivers, and also that above Alsop Ranch. Sheets 28, 33, 34, 35, 36, 37, 38

and 39 of Defendants' Exhibit 114, album of plane table survey sheets, were used in compiling portion of this tabulation, Exhibit 117. Those are maps I referred to in my testimony when stating that some of this area in the Little Laramie was mapped. That above part shown in these maps was covered by plane table survey but not mapped. I actually sketched my work on board as I went above that portion shown on these sheets.

2763 Three months of labor was expended in making survey of irrigated land areas in Little Laramie Valley. Had full plane table survey crew about two weeks. Rest of time had help of one assistant.

Defendants' Exhibit 117 contains five sheets. Various classifications appear at head of columns of each set of figures. In meadow classifications, native hay meadows appear on these sheets as first, second and third classes. Later third class meadow sometimes appears as irrigated pasturage. Reason for this change was that at original starting of survey we termed third class meadow what the plaintiffs termed irrigated pasturage; and after plaintiffs had put on an exhibit so classifying this meadow land, we changed our classification to include irrigated pasturage for uniformity. On tabulation, Exhibit 117, third class meadow and irrigated pasturage refer to same class of meadow. There is a portion of irrigated pasture that did not carry foxtail that was designated as third class meadow and was included in third class meadow classification. After changing method of classification, foxtail meadow and irrigated pasture is included under the heading of "irrigated pasture," while meadow that is clear of foxtail is included under the heading "third class meadow." For purpose of this classification, the two columns entitled "third class meadow," and "irrigated pasture" may both be considered as referring to irrigated pasture.

2764 Referring to Defendants' Exhibit 117, being tabulation of irrigated acreage on Little Laramie River for year 1912, following will be noted:

22,081 acres, total irrigated meadow exclusive of irrigated pasture. This figure includes 2,518 acres of third class meadow. Placing that in column with irrigated pasture and deducting if from total meadow, would give the total irrigated meadow on the Little Laramie River Valley in 1913 as 19,563 acres;

5,801 acres of irrigated pasture, and 2,518 acres of third class meadow appear on Exhibit 117. This gives total acreage of irrigated pasture in Little Laramie Valley for 1913 as 8,319 acres;

219 acres of alfalfa on Little Laramie River, or irrigated from canals taking water from that river during 1913;

1,319 acres of land devoted to growing of oats in Little Laramie River Valley;

88 acres devoted to all other crops, including potatoes, other kinds of grain, flax, and turnips;

2765 There are several small patches potatoes. 5 acres on Sec. 1, Tp. 16 N. R. 76 W. One acre on Sec. 23, Tp. 17 N., R. 75 W. One acre on Sec. 26, same Township and range. 2 acres on Sec. 29, same Township. One acre on Sec. 18, Tp. 17 N.,

R. 74 W. This includes all potato patches in Little Laramie River Valley in 1913. These potatoes were not being grown for commercial purposes but for local consumption, at place where planted.

Potato vines on Laramie Plains were destroyed by frost last week in July, 1913. After frost, vines were black through to ground from their tops.

19 acres of flax on Little Laramie River Valley for 1913;

On Sheet 2, Exhibit 117 there are two items designated
2766 "grain". Do not remember kind of grain that was. Was not oats;

Sheet 4, Exhibit 117, shows notation "two acres turnips". That was all turnips found growing in that valley;

31,341 acres, total acreage found irrigated in Little Laramie River Valley, in 1913, as shown by Exhibit 117. This tabulation covers same area as covered by reconnaissance by R. I. Meeker, witness for plaintiff, and shown on Plaintiff's Exhibit E, from Fillmore to Two Rivers and tributary to Little Laramie River. The two surveys cover same area.

All lands designated first and second class meadows in Exhibit 117 were cut over for hay during 1913, or were land that could have been cut over.

12,129 tons of native hay is my estimate of maximum tonnage that would have been produced in Little Laramie River Valley in 1913 if all first and second class meadows had been cut over. In arriving at that figure, I took total area meadow land capable of being cut, and multiplied by .62, obtained from fields that were a little over average on Little Laramie River, and that gave total of 12,129 tons. The figure .62 indicates tonnage per acre
2767 of native hay. For example, the meadow on Bath Place gave that tonnage per acre in 1913. That meadow was above average of these first and second class meadows included in those columns on Exhibit 117, from fact that it was clear meadow without a knoll. The other meadows appearing on Exhibit 117 had strips of knolls through many of them, some had sage brush, and these obstructions were such as to cut down the tonnage average per acre. I feel that the figures I have given are liberal.

Oats were ready for harvest in 1913 on Laramie Plains region about middle of September.

Frost of July 30, 1913, on Laramie Plains killed buckwheat, beans and potatoes on Wyoming Experiment Farm. Potatoes at that time were about size of hen's egg.

2768 I have compiled tabulation of irrigated acreage under several ditches taking water from Big Laramie River as covered by plane table sheets. That tabulation includes all lands irrigated and plowed. In that tabulation have separated the acreage into various crops to which they were tilled at time of survey.

(Defendants' Exhibit 118, marked.)

Defendants' Exhibit 118 is tabulation of irrigated acreage on Big Laramie River under ditches as indicated and determined by

plane table survey. These sheets only include those acreages ascertained by me in plane table survey on Big Laramie, Exhibit 114.

In Defendants' Exhibit 118, have included lands irrigated under Pioneer Ditch, as it existed before construction of new enterprise, the Lake Hattie outlet and Lake Hattie Reservoir, under three heads "Pioneer Lateral, Episcopal and Pioneer." Episcopal Ditch is taken out of Seven Mile Lake and is small ditch running a short distance down below that point. Its acreage is included within Pioneer area. It will be observed on Sheet 15 of Exhibit 114.

2769 The plowed acreage on Section 22 as shown on Sheet 15, Exhibit 114, is irrigated from that ditch.

6,301 acres of land are irrigated as shown under the three headings, "Pioneer Lateral," "Episcopal Ditch" and "Pioneer." Out of the 6,301 acres there were 847.9 acres of land under the Pioneer Canal in 1913 that was not cropped. It was ground that had been plowed, some of it in previous years. This figure of 6,301 acres does not include all of the land irrigated by the Pioneer Canal, owing to fact that the plane table sheets do not include all of the area irrigated by that canal. Assuming for purpose of question, that we were to take reconnaissance of R. I. Meeker, Wyoming engineer, for acreage under Pioneer Canal and not included in plane table sheets, total acreage under canal above the area covered by sheets would be 6,235. Taking the Meeker figure 6,235 acres as the irrigated acreage of Pioneer Canal above plane table survey sheets and my figure of 6,301 acres as the acreage included within the plane table sheets and irrigated by Pioneer Canal, total irrigated acreage under the Pioneer Canal would then be determined to be 12,535.9 acres, which includes plowed ground, after deducting plowed ground.

11,688 acres of land irrigated under Pioneer Canal in 1913. My recollection is that Mr. Meeker did not include plowed ground in his estimate. I accordingly make deduction of plowed ground in order to get irrigated acreage in 1913. Mr. Meeker had assistance of Mr. Titus, the Superintendent of Pioneer Canal, in making his reconnaissance. I did not have assistance of Mr. Titus in my work.

80.8 acres of irrigated lands of all classes from Sodergreen High Line Ditch (Mr. Sodergreen's new canal) appears on plane table sheets. That does not include actual acreage lying to north of plane table sheets between there and Lake Hattie. Some of that land has been irrigated. Mr. McAnally included this acreage in making his reconnaissance in that region. He did not separate acreage irri-

2771 gated by that canal from that irrigated by other canals in that vicinity. Am unable to give actual acreage irrigated by the Sodergreen High Line Canal. Same is true of Parker and Last Chance Ditches. The figures in my table showing portion of irrigated acreage on lands covered by the plane table sheets give, for the Parker Ditch, 157.9 acres and for Last Chance Ditch 174.9 acres.

9.8 acres of irrigated land in 1913 under Sodergreen South Ditch. Acreage was all covered by the survey.

519.9 irrigated acreage under Sodergreen Ditch. Covered all lands irrigated by that canal in plane table survey.

Island Ditch covers 27 acres. It is owned by Mr. Sodergreen. It is a very small ditch and does not carry very much water.

Some of acreage given for Parker Ditch is included in Sodergreen ranch. It is shown on Section 30 in tabulation. It appears as acreage belonging to Sodergreen. There are 14.7 acres. Re-
2772 mainder of land irrigated by Parker Ditch is on Johnson and Watson places. The Watson acreage is in meadow and oats. There are 62.9 acres. That acreage was obtained by plane table. Went over there for section corner.

1700.3 acres irrigated by Riverside Canal No. 1.

3,283.9 acres irrigated under Riverside Canal No. 2. On Tabulation lands irrigated under that canal are described as under the canal and Riverside Lateral No. 2.

724.7 acres irrigated by King Ditch and also Upper King Ditch. Made observations to irrigate acreage under King High Line Ditch. It is a new canal constructed within last 2 or 3 years. It follows same line as King Ditch for part of its course, then it divides and runs over to Sand Creek, and down to Hutton Lakes. King
2773 High Line Ditch and Hutton Lake Reservoir is not a completed enterprise. Found 286.1 acres irrigated from King High Line Ditch on Riverside Ranch.

Olsson Ditch irrigates 356.3 acres. 20.2 acres irrigated by Olsson South Ditch. That includes all acreage irrigated by both of these canals.

125.6 acres irrigated by Durant Ditch.

279 acres irrigated by Hammond Ditch. That is all acreage irrigated by Hammond Ditch.

423.2 acres total acreage irrigated by Mansfield Ditch. It is owned by Mr. Mansfield and irrigates his ranch. His ranch lands are shown on Section 20 in Exhibit 114.

Unable to obtain irrigated acreage under Fischer Ditch because this acreage extended beyond scope of plane table survey. Found 1001.8 acres irrigated by this ditch under plane table area.
2774 This acreage included alfalfa patch on Grable Ranch. There were 88 acres of irrigated alfalfa on the section. That is shown on Sheet 4 of Exhibit 114.

1,560.1 acres are irrigated under Caldwell Ditch.

886.7 acres irrigated under Hoge and Haley Ditch.

372.1 acres irrigated under Bush and Holliday Ditch.

270.3 acres irrigated by Nelson Ditch. On Exhibit 118 the word "Wells" is quoted on map. That refers to fact that he irrigates from wells. In this case there is no diversion from stream. This occurs at Nelson Road Ranch. He irrigates 33.9 acres by this means. It is possible to irrigate lands in this region by pumps.

433.4 acres under Leroy Ditch taking water from Sand Creek.

141.3 acres under the Cook Ditch No. 1.

169.7 acres under Bush Ditch.

146.4 acres from the Garden Ditch.
2775 14.2 acres from the Dwyer Ditch.
101.5 acres from the Pinkerton Ditch.

439 acres from Richards Ditch.
822.7 acres from Red Ditch.
87.2 acres from Cunningham Ditch.
372.5 acres from Hutton Ditch.
These last ten ditches all take water from Sand Creek.
1,885.4 acres of land irrigated from Dowling Ditch taking water from the Big Laramie. That is total irrigated acreage under it.
1,179.5 acres total irrigated acreage under Hutton Ditch, taking water from Big Laramie.
733.6 acres located under Walcott ditch now obtain their water from Pioneer. That acreage is included along with the Pioneer acreage I have already given.
Referring to acreage under Walcott Canal, will state that figures on Exhibit 118 regarding this canal need re-checking. They are now in lead pencil. On examination of ground found that Walcott Ditch was abandoned. Was named Walcott Ditch and not
2776 Walcott Lateral of Pioneer Canal. Total of this Walcott Lateral has been left out in totalling the Pioneer Ditch.
Since previous testimony have checked Exhibit 118 and same is now in correct form for introduction. I now have in my
2777 hand Exhibit 118, Irrigated Acreage on Big Laramie River, Under all Ditches Embraced under Plane Table Survey. This takes place of lead pencil memorandum introduced under Exhibit number last Saturday.

(Defendants' Exhibit 118, tabulation of irrigated acreage of Big Laramie River, offered in evidence.)

At the close of last testimony stated there was an error by exclusion of certain lands under so-called Walcott Canal. That has been corrected on Exhibit 118 so as to place it under the Pioneer Canal acreage. Figures which gave in last testimony relative to irrigated acreage were compiled from imperfect Exhibit 118. In order to correct acreages under Pioneer it will be necessary to correct figures heretofore given.
2778 7,036.9 acres total acreage in plowed ground, crops and meadow, under Pioneer Canal area covered by plane table survey and shown on Exhibit 114. Plowed ground includes plowed lands but not in crop, during season 1913. Without plowed ground there would be total of 5,912.4 acres under Pioneer Canal. 1,124.5 acres of land under Pioneer Canal had been plowed but were not in crop during cropping season of 1913.
Native hay acreage under Pioneer Canal area covered by plane table survey was as follows:
185.7 acres, first class meadow;
2,556.5 acres second class meadow; and 1,524.7 acres third class meadow.
Third class meadow is synonymous with so-called irrigated pasturage.
Alfalfa, 1,187.3 acres; oats, 283.5; other grains, 147.4; potatoes, 17; garden, 10.2; plowed ground, 1,124.5. Total 7,036.9 acres. Acreages include cultivated areas in suburban district immediately

west of Laramie known as West Laramie. Also Wyoming Experiment Station.

10,605.8 total irrigated acreage under Pioneer Canal as ascertained by plane table survey and reconnaissance by Mr. McAnelly.
2779 That does not include plowed ground. There are 1124.5 acres of plowed ground. That should be added to the figures given. 5,912.4 out of the 10,605.8 acres under the canal were covered by plane table survey. Remaining 4,684 acres lie north and west of area covered by plane table survey and noted in Exhibit 114. For that area I have adopted figures of Wyoming engineer, Mr. R. I. Meeker. In ascertaining total irrigated acreage under Pioneer Canal I take the actual acreage on the plane table area and as compiled by me, and the R. I. Meeker figures for the excess area not covered by plane table survey. These two taken together show 10,605.8 acres irrigated under canal in 1913.

I desire these corrected totals to be taken in lieu of former testimony.

Mr. Meeker showed on acreage under Pioneer not covered by plane table survey:

Oats, 1,569 acres; alfalfa, 94 acres; meadow, 2,273 acres; and irrigated pasturage, 748 acres. Total, 4,684 acres. Mr. Meeker testified that total irrigated acreage under Pioneer Canal was 11,486 acres. My figures are computed from plane table work and with assumption that Mr. Meeker's figures for Pioneer area not so covered were correct, give total acreage under Pioneer Canal of 10,605.8. Difference between my figures and Meeker's 880 acres. My figures show this much less. This difference would, of course, be charged against the area covered by the plane table survey. Assuming, for purpose of question, that as great a discrepancy in the area occurred outside of plane table sheets as occurred in area within the sheets, approximate difference in acreage obtained under canal outside of plane table sheets would be 700 acres. Total discrepancy between Meeker's testimony and mine would be 1,580 acres. Meeker's computa-
2781 tion would show that much greater acreage than mine. Discrepancy when expressed in percentage would be 15 per cent. Even assuming acreage given by Meeker, outside of plane table area, to be correct, the 880 acre difference would make a difference of 8 1/3 per cent. That is discrepancy percentage as to whole area, assuming Meeker's acreage to be correct outside of plane table area.

11, 124 acres total irrigated area in Big Laramie River Valley outside of portion covered by plane table survey.

38,241 acres total irrigated area in Big Laramie River Valley including plane table area and that outside of that area located
2782 north and west of same. From this figure are omitted irrigated lands on Sand, Soldier and Five Mile Creek-, and one or other two minor tributaries of the river. These areas are south of area covered by plane table survey. It is small acreage. I have had access to testimony heretofore given by witnesses for state of Wyoming. From this testimony I obtained information that area lying south and east of that portion covered by plane table survey shows:

1185 acres irrigated on Soldier Creek;
300 acres on Five Mile and Willow Creeks.

Irrigated acreages lying under each canal in Big Laramie Valley, covered by plane table survey and shown on Exhibit 114
2783 and 118, exclusive of plowed ground, is as follows:

Sodergreen High Line, 734; Parker, 163.8; Sodergreen South, 9.8; Popp and Barlow, 203.7; Island, 27; Sodergreen, 338.5; Riverside No. 1, 1760; Riverside No. 2, 3,131.5; Mansfield, 446.3; Fischer, 953.3; Oleson, 334.7; Durant, 116.5; Hammond, 259.5; Oleson South, 20.2; Benson South, 11.2; King, 669.5; Caldwell, 1,553.8; King High Line Ditch, 24; Haley and Hoge, 886.7; Bush and Holliday, 370.8; Nelson, 270.3; Wells, 21.6; Leroy, 431.2; Cook No. 1, 141.3; Bush, 169.7; Garden, 93.6; Dwyer, 14.2; Pinkerton, 99; Richards, 439; Red, 822,7; Cunningham, 184.6; Hutton, 372.5; Dowling, 1,855.7; Hutton, 1,205.5; there is a dam in the river that backs up water that covered 130.1 acres. That is in Tp. 14 N., R. 74 W.; it is up stream from Hart Ranch, and shows on plane table sheets 11 and 16 of Exhibit 114. Under Biddick Ditch there
2784 is no land exclusive of plowed ground; under Pioneer Canal there were 5,912.4 acres; Episcopal Ditch, 9.4 acres. This acreage was included under Pioneer acreage as given by me; North Canal from Lake Hattie, 34.2 acres; Grant, 60.1; No Name, 9.9; No Ditch, 94.2; Oasis, 3,334.6; Boughton, none exclusive of plowed ground; total 27,117.2, exclusive of plowed ground.

The term "plowed ground" appearing through totals as given, indicates ground that has been plowed but was not in crop at time of survey. Major portion has been plowed previous to 1913 and had been allowed to lie idle and not put in crop during that year. If I had included all this land which had been plowed but allowed to lie idle without being cropped during 1913, total acreage included within the plane table sheets would be 29,279.3 acres.

In Exhibit 118, that portion designated irrigated acreage under Oasis Canal indicates only that portion surveyed and extending to point opposite Bosler, Wyoming, and not to end of ditch.
2785 Same is true of Boughton Canal. Survey extended to Union Pacific Railroad.

Acreage included under term "no name" indicates that there is no ditch covering acres. Irrigation is by sub-irrigation. Lands are along river. They are in immediate bottom next to river.

29,279.3 acres irrigated in Big Laramie Valley as ascertained by plane table survey, as shown in Exhibit 118, including acreage of plowed land abandoned for use in 1913. This acreage is subdivided into following classes of irrigated land:

First class meadow, 3,104.6; Second class meadow, 14,547.3; Third class meadow, or irrigated pasturage, 6,936.8; alfalfa, 1,440; oats, 831.6; other grain, 211.9; potatoes, 27.4; garden, 17.6; plowed land, 2,162.1; Grand total including plowed land, crops and meadow, 29,279.3.

9,602 tons of native hay would be total production of the 17,651.9 acres of native hay land, assuming that first class meadow would

produce average of ¾ tons per acre per annum, and second class meadow would produce average of ½ ton native hay per acre per annum.

In classifying this meadow land, I stated that we included under second class meadow, all hay that was cut that would make under ½ tons per acre. I included under first class meadow all that was cut and would make over ½ ton per acre. It follows that figures of tonnage I have given are very liberal according to classification.

2,160 tons of alfalfa hay would be annual production from 1440 acres of alfalfa assuming annual production of 1½ tons per acre. This is acreage included in lands covered by plane table sheets including Hart Ranch. Alfalfa on that ranch seemed to receive best care of any alfalfa on Laramie Plains region. That seemed to be main use to which they put that particular bench land. Lateral that ran through there was essentially for this land. I would
2787 say that it was the best alfalfa field there was in Laramie Plains region. The 1440 acres includes the alfalfa on this ranch.

July 7, 1913, date of beginning of first cuttings of alfalfa on Hart Ranch, Laramie Plains. Second cutting was on September 18th. They used the "Go-Devil" outfit to put up hay same as in Poudre Valley.

There is less irrigated land under Oasis Canal outside of than inside and included within survey. Would think there is proportionately less outside. Ditch is pretty long and upper portion of lands under ditch get major portion of water. Plane table
2788 sheets cover this upper portion of canal. These lands are better and more thoroughly irrigated than lands under lower portion of canal outside of survey.

I have checked over testimony of Wyoming witnesses relative to irrigated areas under canals not included in plane table survey, and as well as those included within that survey. 890 acres of irrigated land under Oasis Canal outside of plane table survey as given by Z. E. Sevison. 424.6 acres of irrigated land under Oasis canal as ascertained by my survey and Mr. Sevison's testimony. I made reconnaissance of the land below plane table sheets and east of U. P. Railroad, with one man and a team. I also had, in connection with this, tabulation of Mr. Z. E. Sevison, showing adjudicated water rights as determined by the courts, and notation concerning every quarter section under Oasis Ditch. With these figures to aid me, I made reconnaissance and determined 890 acres of irrigated land under Oasis Ditch outside of and below plane table survey. Did not make reconnaissance of Boughton Ditch. That Ditch and Oasis Ditch are parallel and near to each other and there was certain amount of observation made concerning that ditch. The figure I obtained for Boughton Ditch was taken from testimony of witnesses for plaintiff and showed 1,550 acres irrigated meadow under that canal.

2789 375 acres irrigated meadow land under Cooper Lake Ditch. Witnesses for Wyoming gave 750 acres under that canal, only fifty percent of which, however, was irrigated.

998 acres of irrigated land under Gillespie Ditch, outside of plane table survey.

705 acres under McGill ditches. Last two figures are obtained from testimony of Wyoming witnesses.

2790 3,400 acres of land irrigated by Sodergreen High Line Canal in upper portion of valley. I obtained this information through testimony of Mr. Sodergreen. He stated land he owned and amount of land irrigated on each section, with the exception of one. For this latter section I took Mr. McAnelly's figures and adding the acreage on this section to the total given by Mr. Sodergreen, I obtained total of 3,400 acres.

1,600 acres of land irrigated by Parker Ditch, other than that covered by survey. Obtained this through witnesses' testimony—witnesses for plaintiff.

1,120 acres irrigated land under Popp and Pahlow Ditch. This is acreage outside of that included in plane table survey.

320 acres of land under Fischer Ditch outside of plane table survey.

42,759 acres, total irrigated acreage in Laramie Valley, exclusive of Little Laramie Valley, including portions south and east of plane table survey and irrigated by Sodergreen High Line, Pioneer, Parker, Popp and Pahlow, Fischer, Oasis, Boughton, Copper Lake, Gillespie, McGill ditches, also including total area within plane table sheets, and portion of Sand Creek area.

2791 Have already testified to total irrigated acreage in Little Laramie Valley. (Page 2766, 31,341 acres.) This acreage included that below Fillmore, or locally known as Wright's Ranch.

800 acres irrigated land on Sand Creek, above point where plane table survey reached. Obtained this from other sources of information. This acreage does not appear on Exhibit 118.

90,610 acres total irrigated acreage in State of Wyoming in Laramie Plains region irrigated from Laramie River and its tributaries. This acreage total obtained by me from various sources of information already enumerated. This acreage is located

2792 on Laramie River and tributaries between the interstate — between Colorado and Wyoming and the cañon of Laramie River below Wheatland Reservoir No. 2. It is located exclusively in Laramie Plains area. Not in vicinity of Wheatland, Wyoming. I have not attempted to give any acreage east of Laramie Mountains or Black Hills.

There is not as much land under irrigation at present time throughout Big and Little Laramie Plains region as there was at some prior time. This is true both under Pioneer and Oasis Ditches. The column of plowed land on Exhibit 118 under Pioneer Canal of 1,124.5 is determined by plane table survey. It covers about 5/9's of area under Pioneer. It would indicate that at some previous time this ground had been plowed and seeded, but is not at present under crop.

Under Oasis ditch there is big item of plowed ground that at one time was cultivated and probably sowed to some crop. At present time it is lying idle.

Country general- gives appearance of falling off of cultivated and irrigated areas. That is true of all ditches that have plowed ground below them.

2792 Have observed flow of water in Soldier Creek at its mouth. About Sept. 15, 1913, I had occasion to drive on wagon road just south of river above Laramie River and at point where road crosses Soldier Creek there was water running into river.

2793 Think there were about 2½ cubic feet per second flowing. That water came from spring up at the State Hatchery. It was not result of sudden storm or freshet. It was ordinary flow. I would say that Soldier Creek is a tributary of Big Laramie River from fact that water flows down into that stream from it, notwithstanding testimony that Soldier Creek is not tributary.

Cross-examination by Mr. N. E. Corthell:

2793 When I was employed by the Harriman system in investigation projects in its territory my duty was to examine the various projects from all sides, including the agricultural possibilities, and this involved a careful and complete examination of the respective territories from an agricultural standpoint and

2794 not merely a consideration of the prospective business which might be secured. The value of the territory necessarily depended in some measure upon the agricultural possibilities.

2795 My work in the Laramie Valley in Wyoming was confined to the Laramie Plains and occurred only in the year 1913, when I was there from about the middle of May until about the 5th of December. During this period I was upon the Laramie

2796 Plains continuously with the exception of a day or two at a time when I made trips to Denver, these numbering three or four. After the middle of September I was present four days or so at the hearing in this case at Laramie. Another week

2797 perhaps was used in taking pictures and in reconnaissances. I do not believe that aside from these occasions over a week or ten days was spent in other than actual field work. Three days were lost by reason of stormy weather.

2798 I did all of the plane table work myself, and while I was away the party did nothing. The western boundary line of the plane table work on the Little Laramie River that was mapped at the time was one mile west of Sprague Lane, being the

2799 north and south middle line of Township 17, Range 75. East of this point all of the land irrigated from the Little Laramie River directly was included in the plane table survey, but not the land irrigated from James Lake Reservoir. The northerly limit of the survey on the Big Laramie River was

2800 Bosler, upon the Union Pacific Railroad, being the north line of Section 23, Township 18, Range 74. In that vicinity the survey on the east side of the river covered the Laramie Valley bottom lands, including everything under the Oasis Ditch up to the north line of Section 23, and also the lands on the west side of the river were included. The city of Laramie was not included in the survey. The plane table survey did not cover all of the areas

shown on the sheets but the designations are made from plane table work. Section 25, Township 14, Range 77, shown on Sheet
2801 1 was covered by the plane table survey and also all of the other lands shown on the same sheet and lying north of the county road; also all of the lands shown on the same sheet lying south of the bottom lands on the south side of the river, and all of the designations shown on the sheet are from my plane table survey.

2802 The plane table survey covered all of the land shown upon Sheet 2 of the survey, including that lying north of the county road. The Pioneer Ditch Lateral shown on the sheet is not shown in its entire length because it runs into other lands. Neither is it shown to its full extent upon this land, but marked as we would pick it up on the road. All the main ditches are
2803 shown wherever they run, and any laterals on the side away from the river are shown for their entire length. The Pioneer Ditch Lateral extends in a northeasterly direction, but I cannot say definitely where it goes. It is not shown north
2804 of the county road because that area was pasture land and the lateral was not followed out. I do not know how long it is nor what land it serves to irrigate. The lands irrigated under it beyond the plane table survey area are taken up in the summation of lands irrigated above the survey which has been offered. All of the land which is irrigated in Section 22 upon this sheet is so shown upon the sheet. The base line shown on Sheet 2 of Exhibit 114 was run with a transit, and whether the areas north of the county road were taken by means of the alidade and mapped or by means of the transit with field notes makes no difference, as it is all the same thing. The work was put down on the maps at the time.

2805 The base line which was run upon the land shown upon Sheet No. 2 was in a general east and west direction and stations were marked by means of wooden hubs driven in the ground, and from these hubs the plane table survey was made. There was only one base line on the territories shown upon this sheet, and it was run out with a transit. The area on the sheet designated as Sodergreen Lake was accurately located by means of the plane table survey. As I recall, the water was rather low at the time, and if it were higher it might extend across the section line, but when I was there it did not extend in Section 21. My recollection is that the concrete check gates and division gates near the Sodergreen Lake shown upon this sheet were accurately located, and that they are actually in Section 28, but they may be across the line as some of the quarter corners are not in line with the section corners.

2807 There was no land in the area designated as the Watson place shown on Sheet 2 and lying west of the Parker Ditch which was irrigated in 1913. My recollection is that the land east of the ditch is irrigated from the Parker Ditch, but possibly some other lateral may cover it. I do not believe the Sodergreen Lake

shown on Sheet 2 could be considered as a storage reservoir,
2808 in connection with the Pioneer Canal. It is a low depression which might be used as a small equalizing basin, but it could not be much of a storage reservoir. I was not there during all seasons in 1913, so cannot say whether it was used for that purpose. There was no connection between the Sodergreen Lake and the Pioneer Ditch or the Lake Hattie Canal, although water had run into the lake from the canal and made a way for itself. It is not true that all of the water that runs through the Lake Hattie Ditch or Pioneer Canal is run into Sodergreen Lake and then out again through the gates marked on the map.

We did not show the course of the Pioneer Ditch Lateral beyond the county road with any idea of hiding anything. It was not our purpose to run out every lateral, as such work would have required too long a period. We showed the laterals above the main
2809 canals or on the side away from the river, and in all cases we showed the entire irrigated area covered by the survey. In all cases we show the main canal, whether there is an upper lateral or not. In some instances we have shown laterals lying below the main ditch, our general rule being to show the commencement of all large laterals and follow them a distance and then drop them.

I do not know how much hay is cut upon Section 28 shown on Sheet 2. Mr. Sodergreen informed me that he cuts between three and four hundred tons upon his land, but I do not know how
2810 much of that is on the section. This is not one of the best meadows on the river. My classification of the various tracts is based partly on information I gathered from persons with whom I talked and partly upon my own observation of the land itself. My classification was made with reference to the physical conditions appearing in 1913 and not exactly upon the irrigation of the tract in the year 1913. For instance, areas upon the Caldwell and Rickard farms would be simply pasture if the year 1913 alone were considered, for it has been some two years since water has been used there, but I have classified them as irrigated pasture lands. This is also true of the land in Section 25, Township 14, Range
2811 76, and there are other instances of the same kind where lands are classified as irrigated pasture lands although not irrigated in 1913. The rule used throughout the survey was to show all land as irrigated which was irrigated in 1913 or in previous years. In some instances, as under the abandoned Walcott Ditch, where the land had not been irrigated for a long period and had
2812 gone back to its original condition, it was classified as pasture land and not as irrigated pasture land. Also upon the Riverside Ranch, where there was no increased growth of grass by the use of water, the land was classified as pasture land, and wherever lands upon that ranch are so designated upon the survey there had been no irrigation to increase the growth of grass.

The water from the Lower King Ditch runs down through the greasewood in gullies and natural diversions to land near the river which is irrigated. The intervening area of greasewood land is

full of pits and knolls, and I would not consider it as irri-
2813 gated land. There are no large laterals, and I would doubt there being several miles of laterals, some on each side of the King Ditch, and I doubt if there are any laterals running
2814 south of the King Ditch and irrigating lands which I have marked as pasture lands. The Upper King Ditch is an old ditch practically as old as the Lower King Ditch. I talked
2815 about the irrigation along the King Ditch with Mr. Ware, the foreman of the Riverside Ranch, who has been foreman for two years but has been in the vicinity before. I do not know how long any of the several persons designated as owners of the Riverside Ranch lands have lived in the vicinity. I also
2816 talked with Mr. Sodergreen, who was an old resident, and with Oliver Mansfield, an old resident, but only with Mr. Sodergreen about the King Ditch.

The principal area of meadow land irrigated by the King Ditch along the River is shown upon Sheet No. 5, and all of it
2817 touches the line of the ditch itself. The ditch designated as the King High Line Ditch is a new ditch, and the ditches designated as the Upper and Lower King Ditches are old ditches. The Upper King Ditch runs from Sections 6 and 5 in Sheet 6 into Section 4 in Sheet 9, and its principal use seems to be for
2818 the oat fields shown on Sheet 4, and from that point it drops into Section 33 and wastes into the lakes shown below. The lower mile of the Lower King Ditch shows no evidence of irrigation in 1913 or in the few years preceding. Where it leaves Section 32 and runs through Sections 5, 2 and 33, it seems to fol-
2819 low the natural course, and I do not believe was a constructed ditch. My recollection of this particular area is rather distinct on account of our difficulty in finding section corners. It is difficult to state just where the ditch ceases to be a ditch and becomes a waste-way, but in Section 32 it flows below the lowest land through a series of ponds.

2820 The course of the Popp and Pahlow Ditch shown upon Sheet No. 2 in Exhibit 114 was determined by survey and is correctly shown as running through Section 23. It does not run to any extent through Section 22. The course of the Parker Ditch is also accurately shown through Section 22 as determined from actual plane table survey, including the part lying north of the county road. The Sodergreen High Line Ditch shown on
2821 Sheet 1 is correctly shown as determined from actual survey across Section 30. The rye field shown in Section 30 is irrigated from the Parker Ditch, as shown by the tabulation marked Exhibit 118, which was made up from the data found by the plane table survey and also from other observations. There are two ditches, one above the Sodergreen High Line running through Section 36 shown on this same sheet, the upper one
2822 not being in use and the excavation having been levelled. These two ditches actually exist. The upper ditch is about the same size as the Sodergreen High Line Ditch and is bridged

where it crosses the county road, and the excavation was
2823 not completed so as to have permitted water to run through. I have been at the head-gate of this ditch but cannot state positively where it is located. It is above the survey.
2824 No part of Section 30 shown on this sheet lying north of the county road shows any signs of being irrigated, although the ditch runs through that portion. The meadow shown in the eastern part of Section 29 on Sheet 1 is part of a field belonging to Mr. Sodergreen, who irrigates land from his own ditches and from the Parker Ditch. Whether he irrigates land from the Popp and Pahlow Ditch I do not know, as he is a large land owner and I am not familiar with all of his lands. The slough shown on Section 32 upon this sheet was located by actual plane table survey and is accurately located on the sheet. The 68 acre
2825 tract on Section 36 on Sheet 1 designated "third class meadow" has knolls in it and is more uneven than land further down the river. It is irrigated pasture land and was not mowed in 1913 and contains no alfalfa, there being no alfalfa in Section 36. The land on both sides of the road leading from the county road to the headgate of the Pioneer dam on Section 36 is
2826 of the same character, being all third class meadow. It was not producing half a ton of hay to the acre at the time the survey was made. The land north of this road is irrigated from the Sodergreen High Line Ditch. The road to the
2827 Pioneer dam was located by survey. The land in Section 29 on Sheet 1 marked "pasture land" has no surface irrigation, with the possible exception of a little seepage near the ditch. I would not say that the land in this section designated "second class meadow land" is among the best of the meadow lands on the Laramie River. This tract is full of boulders, and further
2828 down the river the land is more level. None of the land shown in Section 32 on this sheet which is designated as pasture land is irrigated. The Fischer and Riverside ditches pass through this area in a cut, and the land is not irrigated.

2830 Cross-examination by Mr. N. E. Corthell:

I know of no ditch irrigating about 200 acres in the south half of Section 29 on Sheet 1 by the name of the Jones and Norton Ditch. These lands are shown on the plat to be irrigated,
2831 and they are irrigated in part from the Sodergreen Ditch and in part from the Popp and Pahlow Ditch, the former irrigating most of the area. Certain lands are designated on the plat as "third class meadow," "second class if irrigated," this designation being used in certain cases where the lands had once
2832 been irrigated and would become second class meadow land if they were now irrigated for a proper period.
The large triangular area in Sections 34, 35, and 3, on Sheet 3, is designated as pasture land because if it had ever been irrigated it had reverted to its original state. There may have been
2833 laterals across the land but no system of irrigation, and if water was run across the land it was only through depres-

sions and it was not spread so as to increase the growth of
2834 grass. The river does not run into Section 35 shown on this sheet. I meandered the stream at every bend and it does not touch the section as shown by the corners found on the land.

2835 All of the lands upon which symbols appear shown on Sheet 4 were covered by the plane table survey. The corners of Section 13 on this sheet were fixed by survey and no plane table work inside the section was done, as all of it was pasture
2836 land. That part of Section 18 on this sheet showing symbols was mapped by means of the plane table survey. There may be laterals in this section which are not shown on the plat and there may be a lateral irrigating land north and west of the most northerly ditch shown on the plat. I know of no lateral from the Popp and Pahlow ditch entering the section near the northwest corner and extending southerly and easterly in the east half of the section, but there may be such a lateral. There might
2837 also be a lateral from the Pioneer Canal entering the section. I have not attempted to show all the laterals. The Havenek land in this section which is credited to the Fischer Ditch might be irrigated from the Popp and Pahlow Ditch, but
2838 there can be no mistake in the acreage irrigated as that was determined by the survey. There was not as much as 70 acres nor more than 38 acres of oats growing on the land in
2839 Section 18 owned by Harvenek. I did not locate on the map the buildings and improvements of Harvenek, Larson, and Lund, which are on this section.

I have not shown the improvements of Mr. Olsen on Section 24 on this sheet. I do not know whether any land is irrigated in the northeast quarter of Section 24 as that was beyond the extent of the plane table survey, which extended only as far north as the symbols indicate. This is also true of the Chris Olson land in the northwest quarter of Section 24, but any irrigated acreages in Sections 18, 24, or 13 beyond the plane table area are included in our summary of irrigated areas, taking the figures supplied by the plaintiff's witness, Mr. Meeker. This is true of all lands not
2840 covered by the plane table survey. Where the symbols extend clear around the tract it indicates that the whole area is of the character indicated, and where no symbols appear it indicates that the survey did not extend over that part of the land. The improvements of Mr. Grable upon Section 17 of this Sheet 4 are not shown on the plat. The oat field in this section is as good as there is on the Laramie Plains on the Big Laramie River, but I do not know what the yield was, although I endeavored
2841 to get the threshing record. These oats were four inches high on June 16th. There was no land irrigated southwest of the Fischer Ditch on Section 17 to a sufficient extent to increase the growth of grass, and there were no signs of this area having been plowed. I noticed no barley to the northwest of the
2842 county road on the Grable land in the field marked "oats." The balance of the land in Section 17 lying north of the

road is second class meadow, being 195 acres in area. There is no oat field south of the road in Section 17 excepting as shown on the plat.

The location of the Caldwell Ditch in Section 32 on Sheet 5 was determined by stadia measurements. It runs south of the buildings and not north of them, the ditch running north of the buildings being a lateral of the Caldwell Ditch which I followed out from its source. There is a division of the Caldwell Ditch near the buildings and we took the upper line and ran it out, not following out the lower line which runs north of the King buildings. I am certain that there is a physical connection between the Caldwell Ditch and the ditch running south of the buildings on Section 32. None of the land designated as pasture and greasewood in the southern part of Section 32 on Sheet 5 is irrigated, and if it was ever irrigated it shows no signs of such irrigation now. The land in Section 25 on this sheet consisted of knolls and irrigated meadow, about half of it being irrigated, but all of it was included in the tabulation as third class meadow. Some of the land in this section is irrigated from the Mansfield Ditch by means of a lateral which I followed out. Some might be irrigated from Riverside No. 2 Ditch, the water being carried across the Mansfield ditch, but I do not know whether such is the case. The land in Section 31 on Sheet 5, lying south of the King Ditch, is full of greasewood and was not irrigated to any extent in 1913. None of it is heavily sodded land. I do not know whether the land in Section 36 on Sheet 5 lying between the Mansfield Ditch and the Riverside No. 1 Ditch is irrigated from either of those ditches or from the Riverside No. 2 Ditch, but I believe it is irrigated from the Riversjde No. 1 Ditch.

Section 16 shown on Sheet 7 consists of pasture land, excepting the 66.8 acre area in the southeastern part. At one time the major portions of this land were irrigated, but the laterals are in such condition that they are not capable of carrying water. The land has reverted to its original state. No hay was cut on this part of the section unless it might be a very small amount near the edges of the few ponds on the land. I found no irrigated land in Section 9 on Sheet 7. I found no irrigated land in the west half of Section 11 on the sheet on the north side of the river in the river bottom. On the south side I found 39 acres of meadow in the east half of the section. Near the river, some of the land is sub-irrigated. None of the land in the east half of Section 14 on Sheet 7 lying between the Bush and Holliday Ditch and the Haley and Hogue Ditch is now irrigated, if any of it ever was. We took no elevations of this tract to ascertain whether any of it was under the Haley and Hogue Ditch. We depended upon U. S. Geological Survey bench marks for elevations.

The Caldwell Ditch is what I would call a high water ditch, and at the present time the head-works have been damaged by high water in the river so that water cannot be delivered through the ditch. If a dam were put in water could be taken out of the river at all times.

The land in Section 21 on Sheet 8 designated "pasture land" is not irrigated. It lies on the slope from the top of the bluff to the bottom land and not mostly below the bluff, and is not irrigated from the Fischer Ditch. The land on this sheet lying south of the
2854 Caldwell Ditch receives some water flowing south from the Caldwell Ditch, but no great amount of water flows south from the Haley and Hogue Ditch. None of the land in Section 28 lying south of these ditches is classified as irrigated. This is also
2855 true of Sections 27 and 23. This land south of the ditches is higher than the ditches and there is no indication that it is irrigated in former years. The land in Section 22 lying between the Haley and Hogue Ditch and the Bush and Holliday Ditch shows no indications of irrigation, and if there were ever laterals on the land they are obliterated. I do not remember that there are any laterals in Sections 23 and 27 south of the Haley and Hogue Ditch. Only the land designated as "Oat stubble" in Section 4 on Sheet 9 shows signs of having been irrigated.

2856 There was a lateral running south of the Pioneer Lateral in Section 29 on Sheet 10, and there was not sufficient distribution of water to classify that land as irrigated land. There was not sufficient growth of grass to indicate that it had been
2857 irrigated in previous years. Neither is there any irrigated land in that part of Section 29 northwest of the lakes shown on the plat. This lake was not meandered. The portion of the southeast quarter of Section 30 shown on this sheet which is designated as pasture land is not irrigated, and shows no signs of having been irrigated in previous years. The word "pasture" in the central part of Section 25 on this sheet relates only to that portion of the
2859 section covered by the plane table survey as indicated by the symbols and not to the balance of the section. I do not recall whether the balance of the section has any irrigated land in it or not. The same is true of Section 24. Of the land in the east half of Section 19 lying south of the Pioneer Ditch, only the al-
2860 falfa and plowed land is indicated on the plat as irrigated, and the balance showed no indication of sufficient irrigation to be classified as meadow land. There might be a small area of alfalfa in the grain field indicated in the southeast part of
2861 Section 20 on this sheet. In Section 20 as in other cases, lands which are marked as pasture might at one time have been irrigated, but if so no present indication of irrigation appears and the land has reverted to its former condition. All of
2862 Section 1 shown on Sheet 11 is pasture land and also all that portion of Section 36 outside of the area covered by the symbols. The south canal from Lake Hattie is correctly located on Section 6 and is not extended farther to the north because the survey did not go farther. That portion of Section 31 lying east of the Pioneer Lateral is not irrigated but it may possibly have been irrigated in former years as there is a piece of plowed ground in
2863 Section 32 which receives water through Section 31. I could see no indication of irrigation of the land in the enclosure northwest of the river in Section 32, and found no crops upon it. I

found no potato field or wheat field in this area and I do not
2864 recall any lateral from the Pioneer Lateral extending into it. The Hutton Ditch from Sand Creek shown on this sheet does not enter Section 5 again after running into Section 32.

2865 I do not believe I have made a mistake between the Hutton Ditch and the Dowlan Ditch or a lateral from the Dowlan Ditch in this area as the Hutton Ditch is on higher land. There may be a lateral from the Dowlan Ditch entering this tract, however. When a rodman
2866 picked up a ditch he would follow it out to its end so as to avoid the confusion between ditches. The lower end of Hutton Ditch is in very bad state of repair. Antelope Creek
2867 runs through Sections 30 and 19 on Sheet 13 but is not shown because it is a very small stream which I did not recognize as a creek at the time. I do not know of any irrigation from it, but did not follow it up outside the area of the survey.

2868 85.8 acres were irrigated in Section 16 on Sheet 14, the oat field containing 53.3 acres as determined by stadia measurements. The field contains more than 40 acres I am certain,
2869 but if it contains only 40 acres the discrepancy would be more than is allowable in connection with such surveys. There is not as much as 200 acres of pasture and 60 acres of meadow land irrigated in that section. We found two ponds in this section which might possibly become one in case of high water.

2872 The entire area of the untinted land in Section 26 on Sheet 15 is unirrigated pasture land. Whether it produced any hay in former years I can not say.

2874 That part of the southeast portion of Section 30 on Sheet 18 designated "pasture land" is not irrigated pasture land, but alkali land which I believe was thoroughly moist when I was there in August, and was being used as pasture at the time.

2875 The plot shown as alfalfa land in Section 31 on Sheet 19 was alfalfa land and did not have the appearance of having been plowed up and sown to grain in 1913.

The Walcott Ditch is correctly located through Section 14 on Sheet 20 and the two pieces of alfalfa land are correctly located and the sizes accurately shown, and the barn and house are on the northwest quarter of Section as shown. I do not believe that there is any waste ditch from the Pioneer Canal across this section.

2879 I know of no freshly plowed ground in Section 11 owned by Mr. Salmon and seeded to alfalfa in 1913. There was an old plowed piece near the road which I passed a number of times in June and July, but I saw no signs of any alfalfa.

2882 The area in Section 12 on Sheet 20 near the middle of the west side of the Section marked as pasture land was not sufficiently irrigated, if irrigated at all, to be considered as meadow. I do not know whether any of it was cut over in 1913. I do not know what the hay yield was on the portion of the section classified as second class meadow. That portion of the southeast
2883 quarter of the section lying north of the river designated as pasture land was not irrigated to an extent sufficient to classify it as meadow land.

2884 That part of Sections 20 and 29 lying west of the Laramie River shown on Sheet 21 was used for pasture for stock, being held at the stockyard, and was not irrigated to any extent and is classified as pasture. If any water has ever been put on the 2885 section it was not sufficient to increase the growth of grass. I was on this land after the usual irrigation season for meadow lands. Gravel for stock cars is procured from sec- 2886 tion 20 at a point possibly one-third of a mile from the river, approaching to within about one-twelfth of a mile from the river. I do not recall any waste ditch from the end of the Pioneer Canal in Section 18 on Sheet 23 leading to the river. The 2887 method of conducting this plane table survey was to establish stations from base lines, and from these stations take sights to the various rodmen in different directions, these directions being platted on the plane table. As many stations were established 2889 as were necessary in view of the conditions found and as many sights were taken from each station as was practicable. In some instances as many as 40. The maximum length of the sights was about 2800 feet, but the length would depend on the conditions, the average being 800 to 1000 feet. The wind blew perhaps three days out of four, mostly from the west, and I re- 2890 call t' ree days when we had to stop work on account of the wind. I had three or four rodmen in the party the whole time, and they followed my instructions in determining the points at which they would set up their rods. I have not shown all 2894 of the ponds nor all of the large ponds in this area upon the plane table maps. There are a great many small ponds in the country and a number of large ones which I recall but which are not shown. Some of the ponds which are used for the 2897 storage of water are being turned into reservoirs and water is being diverted from some. Practically all the long ditches waste into ponds. I made no effort to estimate the amount of water wasted by being turned into these ponds.

GEORGE P. WOODALL, continued.

Redirect examination by Mr. Fred Farrar:

Plane table survey as shown by plats in Defendant's Ex- 2899 hibit 114, includes main body irrigated land Laramie Plains region from point at or near Woods Landing, up towards Wyoming-Colorado line, extending thence down the course of river to point six miles below Two Rivers, and also up Little Laramie river from Two Rivers to line one mile west of Sprague's Lane. Lands which I mentioned as lying to north of main traveled highway extending up and down river above Laramie City, which are not covered by plane table survey, have been shown by me from transit observations and reconnaissance. These last mentioned lands were not included in plane table survey, owing to fact they were scattered, small areas that would require considerable time and great expense to make survey, and constituted but a small part of the total area of the Big Laramie Valley. Regarding some of these isolated tracts

I will state that I made no attempt whatever to show them on the plane table survey. Others which I have shown, were brought into plats from transit measurements and from reconnaissance. Lands on Little Laramie River above the line one mile west of Sprague's Lane, were covered by plane table survey, but were not platted. Exhibit 114 does not purport to show them all. The last mentioned area does not include James Lake area. That area is not shown on plane table survey. It was taken by Mr. McAnelly.

It was not design or purpose in making plats to show lines of laterals or lateral ditches. I designed to show main body of irrigated land included within those lands which would be brought under irrigation by extension of main ditch through lateral.

It was not my intention to show full length of South Canal of Lake Hattie Outlet on Sheet 11.

Plats appearing on Exhibit 114 were not designed as survey of ditches, except as they were incidental to showing irrigated area.

2901 I was interrogated on cross-examination with reference to specific areas of land which I designated as pasture and which question implied were thoroughly turfed. As matter of fact territory given outside of high lands and aside from greasewood lands, is all covered with a turf. At times turf is heavy. Presence of turf would not render land agricultural or hay land.

S. E. 1/4 of Sec. 30, Tp. 16 N., R. 83 W., a portion of which appears on sheet 18, is heavily alkalied. It is in a condition of seepage.

Different and duplicate corner stakes prevail frequently in Laramie Plains. In several instances I found that condition, especially along Big Laramie River near Hart Ranch. Surveys and line will accordingly vary according to the particular stakes from which they are made, assuming use of a stake. With reference to the question as to whether or not all the sections were not correctly marked with stones by Government Survey will state, that Government Survey in West is generally in poor condition. Very poorly surveyed. Markings in great many instances are obliterated and cannot be found

2902 I have positive assurance that many section corners were located and established by counting revolutions of wheel of wagon under direction of person sitting in wagon with pocket compass, to give directions. I was not attempting to make a land survey for purposes of determining lines and section corners in making plane table survey. It would not be surprising if my lines as shown on plats might vary somewhat from other surveys which may have heretofore been made in Laramie Plains region. I would state that the plane table survey is very much ahead of measurements by tape from standpoint of accuracy.

In plats on Exhibit 114 I have not attempted to note small ponds.

Interrogatories on cross-examination relative to railroad grade on sections 11 and 12, Tp. 15 N., R. 73 W., Sections shown on Sheet 20 or Exhibit 114, was old abandoned railroad grade which formerly ran from Laramie to Alkaline Lakes to southwest. There is no railroad in existence there at this time.

Classification of lands, particularly of meadow lands, into first, second and third classes was made by myself. Of necessity this involves personal judgment. It is possible that what I might classify as poor meadow might, in the judgment of some person from Wyoming, be considered good meadow. In other words, I was
2903 not attempting to assume the Wyoming standard of values in this classification but merely my own. In making the classifications of these meadows I based my conclusions on conditions of Laramie region alone, not taking into consideration any other localities for comparison. It is possible that some of these areas which I have classified as pasture land, some other person, either for purpose of this suit or otherwise, may have seen fit to mow later in the season.

Redirect examination continued by Mr. Delph E. Carpenter:

2904 Acreage which might possibly have been irrigated from James Lake Outlet of James Lake enterprise, was not included in total figure for irrigated acreage given by me in direct examination for the Laramie River above canon below Wheatland Reservoir No. 2. There was practically no irrigated acreage
2905 under James Lake in the year 1913. There had been previous attempts at irrigation and reclamation. In a majority of cases, the people who had previously been attempting to farm that land had left the country and gone to other places. This was evidenced by abandoned ranches.

In total irrigated acreage given, I included acreage watered from Lake Hattie enterprise in 1913 by North Canal. I did not include in that acreage irrigated by that canal any land over which water flowed and wasted from Lake Hattie North Canal during 1913. I did not include any acreage thus irrigated or overflowed by water in area lying east of Big Basin.

Figures for acreage would not be changed even though upon some sheets in Exhibit 114 a particular tract of land is designated as irrigated from some particular ditch, when in fact it is irrigated by some other ditch. The error would be compensating. Acreage under one ditch would become greater and by some amount under other
2905 ditch it would be correspondingly less. In the end, it would neither increase nor decrease the total acreage included within the area covered by plane table survey.

I heard old ditch noted in Sheet 1 of plane table survey, upon which particular stress seems to have been placed by counsel for Wyoming, and by me designated as "ditch not in use" as the Murphy and Collins Ditch. It is line of excavation crossed by road. Road crosses on earth at this place. Whether it was filled in or whether or not original earth was never excavated, I don't remember. Water could not flow through ditch. In any event, so far as irrigated acreage is concerned, it makes no material difference whether there happens to be small acreage at upper end of this canal irrigated by it rather than by Mr. Sodergreen's High Line Ditch. On same sheet on Section 29, land lying north of Mr. Sodergreen's

house and designated "pasture land," is land with water plane very close to surface. It comes from canon between mountains. Water is close to surface. Seepage appears on this land from Pioneer
2906 and Popp and Pahlow and other canals. There is a growth of native grass and some sage. It is close to mouth of canon and there are large boulders all through that country. At any rate it is used for pasture. Same condition would prevail with relation to NE.¼ of Sec. 32 in the part marked "pasture" on the Durant place. This is heavily covered with boulders and is heavily gravelled in that portion of section. It is not covered with a luscious growth of grass.

Referring to Sheet 3, Exhibit 114, Section 35 and particularly lower portion of that section, concerning which counsel interrogated relative to river crossing portion of the section, while on plane table sheets river does not appear to enter section, will state that stream does not enter Section 35 as determined by section corners on that section. Government stone was on southeast corner of that section, although it does not appear to be in line. If United States Topographic Sheet happens to show river in that section, that is no sign that river does in fact enter the section. I was in position to observe the location of the corners in that locality. I made my sur-
2907 vey from those corners. The map accurately shows the conditions. The United States Geological Survey might have taken another corner further south than the one which I took. River goes near to south line of the section.

I stated there was no evidence of any irrigation in vicinity designated as greasewood pasture on Sheets 5, 6, 7 and 8. If water has been turned on any part of that land in years past, there is no evidence by marked increase of growth of grass that would attract an observer at this time. There is no indication of any irrigation having taken place.

I checked over testimony given by Mr. Winkler, a witness for plaintiff, who stated had been in active charge of this ranch for many years. Total acreage as ascertained by me in plane table survey as irrigated on Riverside Ranch, as compared with total acrege as given by Mr. Winkler, showed difference of 674.2 acres. His total was 10,372 acres, including all classes of irrigated land. My total was 9,697.8 acres. Out of this large area of irrigated land that is the only difference between our figures. It is a fact that Mr.
2908 Winklers figures also dealt with that portion of Riverside Ranch covered by areas noted as grease-wood on my sheets.

There are quite a number of ditches on the Riverside Ranch. They cross and commingle one with another from time to time. It is not a matter of easy location to ascertain these ditches, with the numerous laterals that run out from them. It would not be surprising if an observer should designate a ditch by wrong name in some portion of tract.

Mr. Richard obtains his water supply from Hoge and Haily Ditch and Bush and Holliday Ditch. The Hoge and Hailey Ditch diverted water during 1913. Bush and Holliday Ditch did not, for

reason that ditch was not in condition to carry water. Headworks were in such condition that water could not be taken down into ditch. Dam was not in place. Water could not be diverted into ditch. It is what is known as High Water Ditch.

2909 Lands lying west of Laramie River on Sections 20 and 29 as shown on Sheet 21 of Exhibit 114 and designated as "pasture land," are low lands. Their surface is not far above the water plane of the river. They are of gravelly formation, river deposits. There is more or less seepage in that vicinity and especially on bluffs to west. The natural drainage from the fields irrigated by the Pioneer Canal tends towards river and there is a general leaching out of alkali into the lower lands. A strip of that land extends on west side of river up through this region. There is a tile drain constructed to drain these lands by the Agricultural College. I do not know the exact location. That strip of seepage and alkali lands along river bottom runs past Wyoming Experiment Station Farm. Do not remember how far it goes.

Plats designated as "alfalfa" on Sheet 20, Exhibit 114, in Section 14, which seemed to give counsel concern, and also some land designated as "stubble" lying between these two tracts of alfalfa, will state that there was some alfalfa growing in the stubble, but not enough to classify the land as alfalfa. The growth of alfalfa

2910 was very irregular and sparse. In fact, my recollection of alfalfa field there is that it was poorest on whole Laramie region. I refer to tract designated as alfalfa. There was some scattering alfalfa through stubble. It is fact that owing to presence of few scattering alfalfa plants, some observers might classify it as alfalfa lands. The irregularity of the margins or borders of the lands of the various tracts noted on Sheet 20 is due to fact that there is small natural valley that goes down through there and has irregular boundary lines. There is apparent seepage down through that tract. There is a series of ponds through this locality. The seepage land that gave a growth of grass was designated as "meadow." Where grass was too scattered for meadow I designated it as "pasture." If owners of that land were to put more water upon it, it would bring more alkali to the surface at that point. The growth of grass would be less.

In signaling men in plane table survey, when men were close enough to hear my voice, signalling was done by voice, except when wind was against me, or distance too great, in which case signalling was done by individual flag. Rodmen kept a memoranda of their work as we went along. They had loose leaf note books. Books served as check on my reading with instrument. Each day we checked over our readings from instruments with notes made by rodmen. If we found descrepancies we went back and discovered which one was wrong. Throughout my work, notes of my rodmen checked with notes kept by me.

On Little Laramie River I checked over Mr. Ernest's testimony as to acreage in that valley and particularly as to acreage on

2912 his ranch. I found his estimates of acreage to be very high. Remember man by name of Titus testifying in Wyoming

suit relative to production of hay in Little Laramie Valley, in which case he testified he got up upon the hills and made a horizon survey by his eye and then told about the number of tons in the valley. His estimate of the tonnage of hay in that valley was about 35% too high, assuming that all the acreage of the Little Laramie Valley went as high as the Bath hay, .6 tons per acre. I would say that was not a reasonable degree of accuracy of testimony in a case of this magnitude.

GEORGE P. WOODALL.

Recross-examination by Mr. N. E. Corthell:

2912 Most of the places where I failed to find government corners were along the lowlands, but I do not recall how many
2913 I failed to find nor any record of them. I would say that there were as many as ten corners missing. I do not know definitely that any of the original surveys in this region were made with wagon wheel measurements or by pocket compass courses. I have no notes relative to the irrigated lands under the James Lake system, as that was not under my supervision.

Redirect examination by Mr. Delph E. Carpenter:

By river bottom land I mean the low land lying in vicinity of river as compared with high bench land on the higher lands.

(The following admission was then made:—It is admitted by counsel for Wyoming that an appeal or proceeding in error has been perfected from decree of district court in and for Laramie, County, Wyoming, and that the appeal or proceeding in error *were* perfected taries were adjudicated, a copy of which decree was offered in evidence over the objection of defendants as Exhibit N, by State of Wyoming, the appeal being to the Supreme Court of the State of Wyoming, and that the appeal or proceedings in error were perfected on or about January 4, 1914, but that no supersedeas has yet been perfected from the Supreme Court.)

(End of Transcript Vol. 6—Defendants.)

2916 R. M. GARDNER, a witness for Defendants.

Direct examination by Mr. Delph E. Carpenter:

Photographer. Ralph E. Gardner, my brother, was associated with me during year 1913. Was engaged by State of Colorado to perform services in my line during summer of 1913 in making pictures showing agricultural development under Larimer County Canal and Larimer and Weld Canal in Weld and Larimer Counties, Colorado.

We laid out a highway under each canal and took a picture on each 160 acre tract on both sides of the highway. At the same time we obtained data from farmers and tenants on the land by questioning them. We kept memoranda of dates on which each individual photograph was taken.

Defendants' Exhibit 119 is an album of photographs taken under Larimer County Canal by Ralph E. Gardner and myself.

2917 The particular highway along which these photographs were taken is shown with dark green inked line marked on either side by numbers of pictures on government map in front of album. By government I refer to topographic sheet of United States Geological Survey. I took portions of those sheets and mounted them in this album as a map. Each number appearing in red ink on this main line indicating the highway, indicates a picture following in the book with the same number. In other words, one observing any photograph in this album, may ascertain geological location by reference to number as it appears in red ink on map.

In legends beneath each picture the number of the picture is first noted, then the date and the description of the lands by government subdivisions. We carried with us topographic sheet by the United States Geological Survey while making these photo-

2918 graphs. We used these sheets in checking descriptions given us by the farmers.

Highway under Larimer County Canal, as indicated by map in Exhibit 119, was selected to show heart of irrigated district under this canal through its length. Westerly extremity started near Long Pond near Fort Collins and ran from thence in easterly direction under Larimer County Canal to Olive Branch schoolhouse northeast of Ault. Larimer County Ditch is shown in darker ink outline than other on map. In making this line heavier, I traced the original marking of the Larimer County Canal as shown on the topographic sheet. The highway selected is a well-traveled road. This highway does not follow a directly east and west course, but drops to follow line of canal, showing central portion of irrigated district under that canal..

In this photographic survey no attempt was made to obtain photographs of all the farms or particular crops irrigated by this canal. These photographs were limited mostly to the agricultural

2919 development. For this album there were no photographs taken on lands other than those lying immedately adjacent to and along this one particular highway.

The legend appearing in the front of the album reads as follows:

"Agricultural development under Larimer County Canal."

"This album contains photographs taken by R. E. Gardner and R. M. Gardner of Greeley, Colorado, during year 1913."

"It illustrates the agricultural development on each 160 acre tract on both sides of only one highway through the territory irrigated by the Larimer County Canal of the Water Supply and Storage Company, with the exception of the tracts marked 'X' on the annexed map."

"This highway along which these photographs were taken is indicated on the annexed map. Each photograph bears a number corresponding to a like number on the map, which shows its location."

"Only occasional photographs of improvements appear, owing to

the fact that particular attention has been given to crop conditions. For the same reason, street scenes in Ault have been omitted."

"The date of the taking of each photograph is indicated and the crop development at that date may be ascertained accordingly. The data relative to plantings, yields, ownership, etc., was obtained by inquiry from farmers on the land."

"It is intended to display as nearly as possible the crop development along one highway through this area as it would appear to one traveling along the road. In several instances, more than one photograph was taken on the same tract to better indicate the conditions."

2920 That legend tells the truth. It is from my data. It was prepared by others in the State Engineer's office, at Denver, and then approved and checked and corrected by me.

(Defendants' Exhibit 119, album showing agricultural development under Larimer County Canal, offered in evidence.)

Freehand lettering at bottom of pictures was not done by me, but the legend was prepared by me from my data for this purpose. I have checked over the album since the freehand lettering was put on and found that the legends correspond with those given by me and are correct. In each individual instance, these legends state the facts as I ascertained them. These legends tell what I found from farmers and noted on my map.

The purpose of this album was to show crop development and not street scenes or residences of farmers. At times I took
2921 photographs of residences. As a rule I did not.

I also took photographs along highway situate beneath Larimer and Weld Canal or Eaton Ditch, and through lands irrigated by it. I obtained data for that album in same manner as I obtained data for Larimer County Album, concerning which I have just testified. The same plan was followed.

Defendants' Exhibit 120 is an album of photographs taken by R. E. Gardner and myself during year 1913, under Larimer and Weld Canal. There is a map attached of a similar nature and prepared the same as map attached to Exhibit 119. The highway along which these photographs were taken begins under Larimer and Weld Canal east of Fort Collins at what is known as Plummer school-house and beet-dump. This highway, then, extends in easterly direction through towns of Severance and Eaton, Colorado, to a point six miles east of Eaton. That highway is located
2922 through about central portion of land irrigated by Eaton Canal. It includes newly reclaimed lands by that canal east of Eaton; lands irrigated by extension of Eaton Ditch and newly developed.

First five photographs were made at Fort Collins Sugar Factory.

Legend appearing in this album and on front page there reads as follows:

"Agricultural development under Larimer and Weld Canal."

"This album contains photographs taken by R. E. Gardner and myself during year 1913. It illustrate- the agricultural develop-

ment on each 160 acre tract on both sides of only one highway through the territory irrigated by means of the Larimer and Weld Canal, sometimes known a sthe Eaton Canal, with the exception of three 160 acre tracts, which are unbroken sod, and are indicated on map by 'X'."

"The highway along which these photographs were taken is indicated on the map which is on the reverse side of this leaf. It is but one of many highways that could have been selected."

"Each picture bears a number which corresponds with the same number appearing on the map and indicates the location of the scene with relation to the road."

"The photographs begin at the Fort Collins Sugar Factory and continue as indicated on the map to a point east of Eaton, Colorado."

"Only occasional photographs of improvements appear owing to the fact that particular attention was given to crop conditions. For the same reason street scenes in town of Eaton were omitted."

2923 "The date at which each photograph was taken is indicated and shows the development of the particular crop on that date."

"The data relative to plainting, yields, ownership, etc., was obtained by inquiry from the occupants of the lands."

"It is not intended to illustrate any considerable portion of the development under this canal, but only that which would be apparent to one traveling along the highway indicated."

"In several instances more than one picture was taken on the same tract in order to better illustrate the subject in hand."

"The Larimer and Weld Canal is also designated as Eaton Canal in this and the Industrial Album. This canal is commonly termed the Eaton Canal or Eaton Ditch, owing to the fact that it was constructed under the supervision of ex-governor B. H. Eaton, who was also an extensive owner of land reclaimed by this canal."

"In designating the ownership of lands in this album, the name Bruce G. Eaton, son and principal heir of ex-governor Eaton, is given in lieu of the Eaton estate, owing to the fact that the Eaton estate lands, as well as the private holdings of Bruce G. Eaton, are generally spoken of as belonging to him. A. J. Eaton lands are not a part of the Eaton estate, and neither the estate nor Bruce G. Eaton are interested in them, although such lands are, in the main, under the Larimer and Weld Canal."

"Those lands lying east of Eaton and noted as newly reclaimed are irrigated by means of an extension of the Eaton Canal, constructed during the past eight years."

The data given in this legend has been checked and is correct. The facts therein stated are according to information gathered by myself and brother.

2924 Legends appearing beneath various pictures consisting of number of photographs, date when taken, subject and government description, are true according to facts as ascertained while making this photographic survey. Have checked them over with originals and found them to be correct.

Throughout Exhibits 119 and 120, where, for example, beet crops

were given as 14 to 15 tons per acre, to make it more convenient in striking average between 14 and 15 tons, I used the fraction ½. I did this to save space in legend. Where fraction occurs, it indicates that farmer gave me his crop yield as between certain numbers.

(Exhibit 120, album of photographs showing agricultural development under Larimer and Weld Canal, offered in evidence.)

In taking pictures shown in Exhibits 119 and 120, except where otherwise indicated, I took a picture on every 160 acre tract
2925 on both sides of road. I did not select particular tracts over whole area covered by ditch but only along one highway. In Larimer County Canal album, Exhibit 119, there are only two omissions along highway. This covered ground above irrigation on a knoll. I was instructed to go out later and take a picture of these tracts, but weather did not permit it. In Exhibit 120, under Larimer and Weld Canal, there are only three omissions along the highway. These 160 acre tracts were omitted for same reason as given under Larimer County Canal album.

I was directed to compile from photographs taken by my brother and myself during summer in connection with same work, an album showing various agricultural industries in irrigated area in Cache la Poudre Valley, and particularly along Larimer and Weld and Laramie County Canals.

Defendants' Exhibit 121 is an album of photographs known as the "Industrial Album." With exception of six photographs which were taken by F. E. Baker prior to 1913, these photographs are all our own production and taken in 1913. Legend in front of
2926 album on first leaf reads as follows:

"Industrial Album."

"The photographs contained in this album (with the exception of Nos. 160 A-B-C-D-E and F, inclusive) were made by Ralph E. Gardner and Roy M. Gardner of Greeley, Colorado, during 1913. They were taken almost exclusively upon lands under the Greeley Number Two Canal, the Larimer and Weld Canal and the Larimer County Canal, for the purpose of showing the development of each crop from early growth to harvest or market and to illustrate the fattening of live stock during the winter months."

"This album contains a large number of duplications borrowed from the Larimer and Weld and Larimer County Canal albums and used to better illustrate the industry. Photographs Nos. 160 A-B-C-D-E and F were made by F. E. Baker during years prior to 1913."

"Photographs of towns and cities have been avoided wherever possible."

"The pages devoted to farm homes contain photographs giving a general idea of the classes of homes in the valley. Farm buildings occupied by tenants are not given in this line of pic*ut*res."

"No attempt has been made to obtain the photographs of all items of any one industry, for example, photographs of all feeding lots, etc. in the valley, but only of the typical views so as to give an idea of each crop or industry."

That legend was checked by me and approved. The facts
2927 as therein stated are true. The legends appearing beneath pictures were taken from data obtained by me and my brother while taking these photographs. For example, in the Industrial Album the alfalfa crop; it has been shown from first growth where it is protected by some grain crop through different cuttings, harvesting, baling and feeding of the last growth to live stock. Also feeding of hay to stock in corrals. Relating to grain crop, each grain crop is shown separately in its first growth, then through harvesting and threshing, through elevators and mills to the finished product. Fruit has been shown in the harvest season mostly. Garden produce, such as onions, is shown from growing of seed through cultivation of onion and harvesting. Cabbage is shown early in small plants, to medium stage and harvest. Other garden products are shown growing and harvesting. The last of garden products are shown in pictures of canning factory and additional buildings. Potatoes are generally grown on alfalfa ground. I started with photographs of breaking alfalfa ground. Potatoes are then shown growing through their early stages, then in blossom, then deadened vines and at harvest. Then we find potatoes at last being hauled to market and in the potato warehouses.

2928 Sheets containing 160 A to F inclusive, are photographs taken by F. E. Baker. He was a Greeley artist. They illustrate potato as grown in years previous to 1913.

Sugar beet industry is very extensive and we show that in all its aspects. First photograph was taken June 20, 1913, showing beet when it is first cultivated and during cultivation when second weeding and second hoeing was made. We next show irrigation of beet and beet before it is ready to be dug. We then show harvest of beets. I have shown several classes labor employed in harvesting beets, in particular Mexican, Irish, German, Japanese, and German Russians. In harvest of beet crop pictures I show topping of beets by hand labor, hauling, digging, siloing or piling beets until factory is ready for them. Silos are in both field and at the dump. I illustrate various classes of silos particularly on farmers' lands and
2929 at dumps as well. I have shown the sugar factories in this community with beet dumps and conditions surrounding the factory including feed lots and pulp silos.

In sheep feeding industry, I have shown first grazing on last growth of alfalfa, then in corrals where they are fed alfalfa, grain and beet pulp.

In cattle feeding industry I have shown them grazing on stubble of alfalfa and beet tops, then in corrals where they are fed hay and beet pulp covered with molasses and some grain.

Farm homes which are typical of the valley have been shown, some of very modern construction, having electric lights with modern conveniences.

In making this industrial album I have taken pictures from Exhibits 119 and 120 in some instances. The other photographs were taken under the Greeley No. 2 Ditch and surrounding community the Larimer County and the Larimer and Weld Canals.

Potato yields are designated in bushels. Potatoes are dug with machine digger and gathered by hand. They are sorted by machine, either in the field or potato celler later in season. On practically every farm I saw a potato cellar. Each farm would be pro-
2930 vided with a cellar large enough to hold the potatoes raised on it. The interior pictures of warehouses where potatoes were on storage were made by flash light and time exposure.

(Defendants' Exhibit 121, Industrial Album of Cache la Poudre Valley, offered in evidence.)

In making these photographs my brother and I commenced work June 20, 1913, and completed it December 23, 1913. Photographs were mounted by myself. They were printed from our original negatives. I have checked photographs with negative to see that they are correct. I have checked over the legends in Exhibit 121 and they are similar to those compiled by myself from statistics gathered from farmers. They are true according to facts gathered by me.

2931 LOUIS G. CARPENTER recalled.

Direct examination by Mr. Delph E. Carpenter:

During the time I have been engaged as expert in this case, as well as at previous times during my residence in Colorado, I have had occasion to visit Laramie Plains in Wyoming for purpose of comparing that region with Cache la Poudre Valley from standpoint of possible agricultural development. I have, of course, been very well acquainted with Poudre Valley and have been in the Laramie Valley a few times prior to 1909 and since then quite a number of times. Of course in all these cases I have been very much interested in the possibilities and indications of development not only of these valleys, but any valleys I happened to visit. During the years I was Director of Experiment Station at Fort Collins, and for nearly ten years previous, was in constant touch with the station at Laramie. Have been in touch practically from time Laramie station was organized. Chief of Wyoming Station for many years, went to Wyoming from my office and of course I took interest in his plans and work, aside from the fact that it was a station in line of work that related to our own. I refer to Professor B. C. Buffum, who went to Wyoming in 1891 and who had been in my office for a year or more previous and had graduated from my classes before that. I
2932 have kept in fairly close touch with the institution since the establishment of the station at Laramie. Have kept more in touch with it than I have with most of the stations of the United States because of its being near by and for other reasons.

Meteorological observations were carried on at the Colorado Experiment Station under my direction. They were started, some of them, when I came to Colorado, by Professor Mead who had been my predecessor, then I extended them to a much greater length and a wider bearing. Records of Laramie were started by Profssor Buffum who had been my assistant and observer while he was with me, and when he went to Wyoming he organized their records at Laramie.

He followed then the plans that I had enforced in Colorado and a good many of same lines of observations with same methods.

No difference in obtaining air temperature records at two stations. In Colorado Station I have also series of records giving terrestrial radiation temperatures and solar temperatures that I think were not carried on in Wyoming; that is, solar maximum temperatures were not carried on I know and terrestrial radiation I am not sure of. I think they were kept at Laramie part of the time at least but they were not published in their summary. Distinction be-
2933 tween terrestrial radiation and air temperature, as it is commonly termed, is that terrestrial radiation is temperature kept at the surface of the ground, while air temperature record is kept at some distance above ground,—from 6 to 10 or 15 feet as case may be In case of air thermometer, thermometer is protected from loss of heat by radiation and its purpose is more to get temperature of air at that elevation The terrestrial radiation thermometer, being near grass and open to sky, gives the temperature that is partly due to air next to grass and partly due to loss of heat by radiation to sky. This loss of heat is considerable. Thermometer 6 or 8 feet above ground does not go as low as temperature close to ground, so in Colorado we get records of both of these.

There is variation of from 8 to 20 degrees, or more, between air thermometer, 6 or 8 feet above ground, and terrestrial radiation thermometer near surface. The record is given in Table 20 of Bulletin 182 of Colorado Experiment Station, by averages. Average for years run about 5 degrees different, that is, thermometer near ground is on an average that much lower. But that does not give extremes. The extreme difference would run very much higher than that; that is, on clear nights those differences would run up sometimes to as much as 15 or 18 degrees and on cloudy nights the difference would be less. The temperature at the ground is always lower than that temperature in shelter 6 or 8 feet above ground. Hence the attempt at times to determine whether
2934 there is frost by reading of thermometer 6 or 8 feet above ground is very often misleading and it was very often the case that frost might be seen on the grass and shown by the thermometer, when air thermometer 6 or 8 feet above ground would be from 34 to 37 degrees Fahrenheit, or from 3 to 6 degrees above freezing point.

Record of air thermometer 6 or 8 feet above ground and protected by little house in which the thermometer is kept, is not reliable index as to frost conditions at ground surface.

Referring to Bulletin 100 of Agricultural Experiment Station of University of Wyoming at Laramie, entitled "Meteorology for Twenty Years" by Professor Night and Fitterer, the air temperatures would always be given from a thermometer protected by shelter and when they give the temperatures, which they do, those should be from a thermometer so protected. In exposures of different weather stations instruments are probably exposed to air from 6 to 10 feet above ground. That is the accepted exposure, but of course in cities weather bureau is often restricted to places on top of build-

ings. The records in Table 5 on page 41 of Bulletin 100 would not furnish reliable information relative to low temperature during various months throughout each year at surface of ground, assuming table was compiled from records obtained through air thermometer several feet above surface. The records in this table would simply show reduced temperatures at place where instrument was and temperature of ground would be something lower than that.

2935 Information relative to thermometer from which table was compiled has only been obtained from statements and bulletins. They are given air temperatures and such temperatures would necessitate use of thermometer protected by shelter. A thermometer that is not protected would be affected by radiation of different objects, and purpose of shelter is to keep off all influences except air itself as far as they can. My impression is, Professor Buffum did start some observations with terrestrial thermometer but I don't think they kept them up. Those instruments are easily broken and required to be replaced on an average of about once a year, so that it is very easy for the series to be broken.

Assuming Table 5 in Bulletin 100 of Wyoming Experiment Station has been compiled from records kept by air thermometer several feet above ground and not by terrestrial radiation thermometer, and basing my observation on information I have of corresponding records almost everywhere and on controlling conditions as well as on our experience at Colorado Station, would say difference in temperatures recorded between air thermometer and terrestrial radiation thermometer would be rather more than they would be at Fort Collins on the whole. On clear nights they would be large. The reason for this difference is that as we go higher above sea level the layer of air is thinner and radiation is more intense. That is true both in day and night. It is seen in day by greater

2936 liability of burning by sun's rays as we go up on mountain tops and same condition prevails at night. It is also shown by familiar fact that temperature drops very quickly after sunset, which is due to radiation that takes place. So, while I do not know exact difference existing at Wyoming Station, it would not be less than at Fort Collins and tendency would be to be more both by reason of elevation and that air is apt to have less moisture owing to local conditions.

Average temperature as recorded between two classes of instruments, is different from what it might be on a single night, or on certain nights it is varying. For instance, at Fort Collins in July an average of 5.4-10 is given, ranging in some years from as low as 3.4-10 degrees in 1911 to a difference of 9 degrees in 1890. The difference at Laramie would be at least as much and I would suppose 1 or 2 degrees greater on an average. On a single night or on certain nights in a month it would be a great deal more. I have observed a difference of 12 to 15 degrees at Fort Collins at times.

In order to obtain low temperatures at the ground surface during any month, it would be perfectly safe to deduct 5 degrees from low temperatures appearing in Table 5 of Bulletin 100 of Wyoming experiment station. It would probably be safe to deduct more than

that for some nights, because of this reason, that during summer months the nights of low temperature are usually clear and of in-
tense radiation, and on those nights differences in air tem-
2937 perature and air close to ground is greater.

For purpose of comparisons of air temperatures and climatic conditions generally, records of air thermometers in two different localities would be sufficient, with a limitation. The person who is making a critical comparison of records of two places would want to know quite a good deal. He would want to know where records were taken and how instruments were located; that is, assuming that instruments themselves were correct. If two sets of instruments are in corresponding exposure and the same height above the ground, then they give a pretty good means of comparison. The air instruments at Wyoming and Colorado are much more comparable than most stations. I have noticed particularly Wyoming instruments but once and I assume that they have been maintained at about same way and instruments have been under much the same conditions.

Relative to physical conditions between Laramie Plains area and Poudre Valley region, I would state soil in Poudre Valley is much better from an agricultural standpoint than that on Laramie Plains.
The Poudre Valley soil is more open more capable of drain-
2938 age and has less alkali. The general climatic condition is of very great importance even where the soil is equally good. The Poudre Valley varies in elevation from 5000 feet at Fort Collins to 4700 feet at Greeley. It is really a little less, about 50 feet in both cases. At highest ditch it is probably 5500 feet or less at the headgate. The irrigated area in Poudre Valley is practically 5000 feet without much difference either way. Laramie Plains has elevation of about 7000 feet at Laramie, so there is a difference in elevation of about 2000 feet.

There is about 2000 feet difference in elevation between the head of the Pioneer Canal on the Laramie Plains and the uppermost canal of the Poudre Valley. Pioneer Canal, as indicated on Map Exhibit 1 is 7431 feet and the canal of The Water Supply and Storage Company has an elevation of about 5500 feet, so that the difference is just about 2000 feet.

Effect of difference of 2000 feet in elevation is to give the higher place the colder climate on an average through the year and especially during the summer. In some places it might affect the winter climate and in some places winter climate may be moderated by an increase in elevation. The marked difference when it takes place is due to what meteorologists speak of as an inversion of temperature partly due to the inrush of cold air along flanks of mountains and raising warmer air up, and also partly due to direction of
winds. Thus, for instance, on Pike's Peak during many
2939 days of winter temperature at top of peak is warmer than at Colorado Springs, and on east edge of Long's Peak, where I have had observations for 20 years kept by Mr. Lamb and Mr. Enos Mills, winter months from December to April average warmer there than down on edge of plains. However, during summer months

there is a decided difference in cooling, so that at elevation of 9000 feet maximum temperature we have ever had recorded is 77 degrees I think. That is at the flank of Long's Peak. At Fort Collins, with elevation of 5000 feet it has gone up to 99 degrees. On whole the summer temperatures are lower on the higher elevations.

This statement is true of all these places. The higher up you go the cooler is the summer. Now in case of Laramie Plains, I doubt if same cause would operate in winter there as I mentioned at Estes Park on flank of Long's Peak, so that winter temperature and summer temperatures both tend to be cooler and certainly, the summer.

Elevation has much the same effect on temperature as is observed in moving further north. So that, for instance, those who describe plant life of elevations speak of the zones of plant growth. You may start with a temperature zone of vegetation at the base of a mountain and you go to the boreal, sub-Arctic and Arctic zones of vegetation by simply going up in elevation; so that we get, for instance, on these high mountains a vegetation that is practically Arctic; Alpine, they then term a portion of it. Hence, elevation has a decided effect upon local climate. You have practically the same effect as though you were going farther north. The two effects are very similar but not absolutely alike.

2940 Ascending from foot of mountain to summit, in some respects, has greater effect on climatic conditions than going north. The effect is shown in summer vegetation. As you go north and increase your latitude, summer vegetation pushes forward with greater rapidity than it would at an increased elevation that we might compare with the difference in latitude. Reason for that is largely due to fact that length of days are affected by latitude; as you go north your days become longer. Twilight is of very great importance from standpoint of plant growth. Light available for plant life increases very rapidly as you go north during summer season; hence well known fact that vegetation pushes forward with greater rapidity during summer and is very luxuriant and crops may be grown very successfully even when ground beneath may be practically frozen. For example, in northern Canada, portions of Alaska and all countries that approach Arctic Circles. You may go up into the air and you will have effect of going north; upon the other hand, length of your days will not be increased; your twilights will be short. It is well known that twilight in tropics is very short, even by our standard. As you go to 55 and 60 degrees, twilight in summer becomes one, two or three hours, because as sun circles it does not get very far below horizon. For instance, I have read common news-

2941 paper print at Edmonton, Alberta, as late as half past nine in the evening,—near ten o'clock.

2000 feet difference in altitude between Cache la Poudre Valley and Laramie Plains region, if converted into latitude, would be in neighborhood of 6 degrees difference in latitude; so that Laramie Plains as compared with Fort Collins, for example, would be equivalent to being 6 degrees further north. Now, basis of that deduction is this, that in taking plants, for instance, trees, the timber line at different latitudes under nearly same conditions, a difference of a

degree in latitude is equivalent to about 300 feet in elevation. It seems to be between 300 and 400 feet in elevation, but on average it would probably be between 300 and 350 feet along the east borders of the Rocky Mounutains.

This would be modified by length of days if question of effectiveness of crop growth is considered. That is, crops would grow more rapidly and better in summer in north latitude than at these elevations further south where temperatures would be somewhat the same.

Conditions of plant growth on Laramie Plains would be not very far different from conditions as we find them at Edmonton, Alberta, eliminating from consideration the difference in length of days. The difference would be rather in favor of Edmonton, as far as crop growing is concerned. That is based in first place, upon
2942 observations as to what they are doing at Edmonton as compared with Laramie Plains. That is, they are growing oats, for instance, on a very great scale at Edmonton and very successfully. There are great many elevators and mills for grinding oats, purchase of oats, etc. On one of my trips over there, I made quite a journey with a man who owned a string of elevators and his purchases were very largely of oats.

On Laramie Plains the country can scarcely be said to have made a success of raising oats, although there have been crops of it. As a whole, the valley has not found it profitable to go into that kind of agriculture or at least it has not done so, except to very small extent. I cannot state yield of oats near Edmonton, Canada, but I know they are raising that crop on large scale, were doing it as a matter of farming and a matter of profit and it justified their agriculture and taking up lands for that purpose. I saw the crops and know they were excellent.

I have seen but very few crops of oats on Laramie Plains. Compared with those I saw at Edmonton, for instance, those at latter place, judging from their appearance, were much more promising and had a general appearance of a successful crop. The vegetation at Edmonton was more luxuriant and the crop yield more
2943 uniform, as a whole.

Comparing agriculturally Laramie Wyoming, and Alaska, I will state, that Alaska is a country of very diverse conditions. Portion along Pacific coast is very different climatically and agriculturally from that of Laramie Plains and very much more favorable. Inner Plateau of Alaska has been doing some very excellent work in that line and tests that have been made in the Fairbanks Station by U. S. Department of Agriculture at Rampart Station are certainly as good as on Laramie Plains and general prospects look very much more favorable. These tests in Alaska have been only for few years back. They have benefit of longer days and longer twilights. Hardier grains and rowed crops are doing remarkably well. The United States Department of Agriculture is on record as stating that the inner plateau is of great area and is likely to be an agricultural country.

As compared with Alaska and northern Canada, exposure of Laramie Plains region is unfavorable from climatic standpoint. It is

valley protected by mountains on south and west and of comparatively easy access for wind movements from north, so that it is not only exposed to very heavy winds lasting nearly all year
2944 through, but it is also exposed to cold waves coming from North and west.

Wind movement on Laramie Plains is about twice that of Cache la Poudre Valley, that is, while in Poudre Valley average wind movement is 5000 miles per month, in Laramie Plains, according to my recollection, it runs about 10,000 miles per month. That is rate at Cheyenne and from comparison made some years ago, my recollection is it was nearly same at Laramie. Wind movement doesn't seem to be recorded in this last Bulletin 100 of Wyoming Experiment Station. Wind movement is an agricultural condition at least to be considered.

Other agricultural obstacles, outside of greater exposure and shorter growing days during summer months on Laramie Plains region, as compared with equivalent projections in more northerly regions of Canada or Alaska, are the soil conditions on Laramie Plains. The great quantity of alkaline soil and of soil that is very difficult to manage is an additional difficulty.

During summer 1913 I went through both Cache la Poudre Valley and Laramie Plains region to study opportunities of both valleys in their agricultural conditions. I went with Professor L. H. Bailey. We visited portions of Laramie Plains region that were stated to be the very choicest spots of that valley, agriculturally. On the
2945 same trip, there was no particular spot selected in Cache la Poudre Valley. Attempt was to show general conditions of the valley and regions showing periods of development and zones of development under different ditches. We then went through those regions for many miles. There was no occasion to single out any particular portion in the Poudre Valley, for it was all good. On one ranch visited on Laramie Plains, the Blackburn Ranch, some oats were growing and some oats were still uncut. This was, however, practically the only bit of cropping growing to any extent, so far as we saw. It was described by the people well acquainted with the valley, as the very best farm in whole Laramie Plains region, and I think has also been mentioned by various Wyoming witnesses.

Blackburn Ranch seemed to be a special case, rather than an illustration of the business of the valley. The ranch lies rather favorably, somewhat sheltered and it also has rather unusually porous soil, and seems to be situated so that water conditions are unusually good. So that, the reasons why that has been doing so well looked to me to be special reasons and not reasons pertaining to whole valley. It had given some straw, yield of grain I did not learn.

Relative to conditions of Poudre Valley, we must have traveled more than 100 miles and throughout whole distance there was a mass of farms, grain, sugar beets and potatoes and whole distance was a succession of houses and crops in high state of excellence. All roads were in good condition. Houses showed considerable prosperity, electric lights, frequent school houses and a general high condition

showing country that was highly developed and very prosperous.

2946 Poudre Valley is a country which will respond to even greater agricultural development than present limits already irrigated. That is my very positive conclusion from my observation of the valley extending over 25 years and seeing its development and studying the conditions that affect it. There has been a constant increase of fertility, population and yield of crops and also evidence of extension of cultivation. There is every reason to expect that same condition will continue and with increased crops there will of course be increased population and wealth. When I first knew valley 25 years ago, a great many were struggling to obtain financial foothold. During that time they have succeeded and it has become an example of an independent agricultural community.

In Laramie Plains region, especially that region pointed out in this case as an agricultural section, for example under Pioneer Canal and along Little Laramie Valley, there was practically no settlement, taking it from standpoint of settlement. There were quite a number of vacant houses that I observed. The houses that are there are almost all simply excuses for houses; shacks. They appeared as though the people were having a hard time to get along. In a few cases stock ranches along the river had more comfortable houses. I do not recall but two or three that were depending

2947 on agriculture to any great extent. I am not even sure that the Blackburn Ranch depends as much upon its crops as it does on the attempts to sell its lands. That ranch seemed to have more comfortable buildings.

They have few farm buildings in Laramie Plains region as compared with Poudre Valley. They are widely scattered.

In Cache la Poudre Valley in 100 miles of inspection I should think we must have passed three houses per mile. It may be rather more than that. In counting up, in some cases as we went along and in other places that I knew, I reached conclusion that there must be about 7 or 8 houses to section. That is an estimate. These were homesteads or family homes. Mostly two story houses, many of them of brick, I should judge of 7 or 8 rooms as a rule, showing in almost every case telephone wires going to houses and a great many house showing electric service wires for electric lights in houses. They were homes of very best country type. Be-

2948 sides these homes, on many places there were houses occupied by laborers, about like those on Laramie Plains. Most farm homes have, in first place, quarters for their men, single men, and now with introduction of beet culture, there have been great many people especially Russians and Japanese, come in and quarters are furnished for such families. These are more or less temporary, that is they are cheap houses of probably two rooms so constructed that these families can occupy them. This Russian, German and other labor has also been used by farmers in other work about farms in addition to beet culture. They were brought in primarily for beets but have been found very useful both before and after beet crop is harvested. It has given a general source of labor. Prior

to introduction of this foreign labor, farm laborers were mostly single men and men of passage as it were, who worked here and there a day as they were going across the country, or, in many cases, they were single men who were getting a start, some of them later becoming renters and owners of land. The labor problem was becoming more and more difficult from year to year, in proportion to agricultural development, because development of more intensified agriculture constantly called for more help. When the raising of sugar beets was taken up the most serious consideration was that of obtaining labor and this retarded development of sugar beet industry in Colorado for probably two or three years until they could get some means of meeting labor demands. These Russians, as they are termed, or Germans who had settled in Russia originally, have come here with their entire families with intention of making their homes and they are forming a permanent element in the community. In many cases they are getting small tracts of land and are progressing just as fast as their savings permit. They are a very valuable foreign element, as a rule.

Laramie Plains region has had all conditions of transportation and access of people that Poudre Valley has had, and, in fact, to a greater degree. The only difference has been that they could not make a success of settlement. Opportunity for development from standpoint of water supply for irrigation has been fully as good and has been less subject to difficulties than has Poudre Valley. Laramie Valley has had water in greater quantities. They have had to do less struggling over it and have had less expense and all those conditions have been favorable to that valley.

Laramie Plains has failed to develop simply because that region is not adapted to agricultural crops. I do not think it ever will be. It is primarily a grazing and stock raising valley. The unfavorable climate is principal cause for its remaining such. It is a sub-Artic region.

From standpoint of opportunity for development, region near Greeley is perhaps nearest comparable with Laramie Plains region under Pioneer Canal in matter of accessibility, transportation, etc., that is, railroad came to Greeley in 1869 or 1870 and railroad went into Laramie in 1868 or 1869. Laramie and Weld Canal was constructed and its lands were made subject to irrigation about same time as Pioneer Canal in Laramie Plains. Laramie and
2951 Weld Canal had great scarcity of water for a number of years, for 8 or 10 years at least, principally because lands had not become saturated and farmers had not become used to getting along with less water. At any rate they felt the need of water. That provoked many suits and a great deal of litigation partly because of situation and partly because irrigation jurisprudence was being developed and certain principles had not been determined. Larimer and Weld Canal has borne brunt of litigation of Cache la Poudre Valley during period of its development, more than any other one company. As a matter of fact that canal, throughout its history has had one continuous struggle in order to obtain water for its lands. It is a large ditch and that perhaps has intensified the struggle.

Have heard all testimony relative to history of Pioneer
2952 Canal from standpoint of water supply. I have gathered impression that there has been no particular struggle for water under that canal, at least not as compared with conditions in Poudre Valley. It has not been necessary for them to be very careful about getting all the water they could at headgate, and they have not had an organization for regulation of water from main stream similar to Poudre River administration in Colorado. Notwithstanding fact that Pioneer Canal, taken as a whole, has had unlimited water supply and Larimer and Weld Canal has had one continuous struggle to obtain sufficient water for its consumers, Pioneer Canal shows scarcely any development and Larimer and Weld Canal has been constantly developing, both in acreage, wealth, population and crops and has become a very rich and fertile country of homes.

Development under Larimer and Weld Canal is very similar to development under other canals in Cache la Poudre Valley. Only difference is, in times past some canals have possibly been a little ahead of Larimer and Weld and some have been a little behind. At present time they are all practically on same general plane of development. They have much money invested in their canals, reservoirs, ditches and lands. An investment that they consider justified by the returns.

2953 There is very little comparative development under Pioneer Canal in Wyoming. The development under these two canals is more a matter of a contrast than comparison. They are so different in degree that they are hardly in same class.

I think history of past 30 years of these two canals is absolutely indicative of general future conditions, because present state is consequent of physical conditions as they have existed in past and will continue in future. In other words, you cannot change physical conditions under these two canals.

If Pioneer Canal area should show an increasing population and cultivation during future years, the growth and increase of population and cultivation under Larimer and Weld Canal would be very much greater and to as great a relative extent as it has taken place in the years past and probably even to a greater relative extent.

Lands under Pioneer Canal are not and will never be of the character that will support dense population or respond to intensive cultivation.

Defendants' Exhibit 116, containing photographs of buildings and improvements designated as appearing under Pioneer Canal, illustrates nearly all the buildings. These photographs do not exaggerate the general appearance and lack of cultivation
2954 throughout the Pioneer area. If anything, they rather tone it down, because in photographs they sometimes give impression of cultivated land when in fact ground is not cultivated. In photograph it is not always easy to distinguish. Photograph No. 127 is perhaps about average, rather better if anything. Photograph No. 119 is one illustrative of general conditions under that

canal. Photograph No. 109 is another. In speaking of general Pioneer Canal area, I do not include the suburban area immediately west of Laramie City, known as "West Laramie" area. It appears that that area does not depend upon the development of its land — its support. I speak of greater body or larger acreage under canal, when considering general class of improvements.

Defendants' Exhibit 120 illustrates with fair degree of accuracy, agricultural development under Larimer and Weld Canal in Colorado. These photographs do justice to general appearance of the fields. As to buildings, my recollection of area is that buildings are rather better than shown in album. I have the impression, on going through the tract, that the buildings are rather better than the impression I get from looking over the pages of this album. That may be due somewhat to the path that was followed or it may be that I was unduly impressed with the better buildings.

2955 None of photographs in Defendants' Exhibit 116 show harvest views under Pioneer Canal. I did not observe any fields in harvest while there in 1913. I saw some fields that had been cut on Blackburn Ranch and otherwise all I observed was hay. There were a few cases of grain stubble but not many. The field of oats on Blackburn Ranch had mostly been cut and stacked. There was a small portion left uncut. Straw was high and partly green.

Grain is not a principal crop under Larimer and Weld Canal.

2956 There are other crops that are more valuable. Grain is largely grown. Do not recall just how acreage compares with other crops. Under system of agriculture prevailing, they grow grain, alfalfa, beets and potatoes over part of tracts at any rate. Alfalfa has greater acreage than grain. Potatoes and beets excel grain from monetary yield.

Outside of hay obtained from alfalfa, its principal use is as a fertilizing crop. It enriches the soil both by storing nitrogen and by decaying of roots. It serves as good green manuring crop and good fertilizer. Alfalfa fields are being constantly broken and planted to some other crop. It would be almost impossible to grow sugar beets successfully and profitably without alfalfa in rotation. Same is true of potatoes and as a matter of fact, is largely true of grain, as yield of wheat has increased in last few years. Prior to introduction of alfalfa, yield of grain was decreasing. System of rotation includes these crops. Alfalfa is given longest time in rotation. Alfalfa generally seeded with grain as nurse crop. Alfalfa follows grain and by seeding together they save some time as they cut the grain in summer and alfalfa well get a start in fall.

2957 There are no towns or villages in Pioneer Canal area in Wyoming, except Laramie. Under Larimer and Weld Canal in Colorado, town of Eaton and several other towns are largely supported by that canal. Windsor is below Larimer and Weld area but principally supported by farms served by that canal. Town of Severance I think is under Larimer and Weld. Lucerne is just on border of area and Timnath and Ault and several others are partly supported from the area. This area contributes in large measure to support of cities of Fort Collins and Greeley, especially the latter.

Eaton, more than any other of these towns, indicates development of Larimer and Weld area. It is more especially a town dependent entirely upon that area and is a reflection of its growth. Growth of this area is reflected to greater or less degree in cities of Greeley and Fort Collins.

2958 Development of Larimer County Canal is of exactly same character as development of Larimer and Weld canal area. Only difference has been that Larimer County Canal area was few years later in starting.

Defendants' Exhibit 119, an album containing photographs taken under Larimer County Canal is fairly illustrative of agricultural development of that area. This canal derives a large portion of its water supply from Laramie River by diversions through Sky Line Canal and Laramie Lake and Lost Lakes. This album is indicative of response of lands under that canal through application of Laramie River and other waters. Prior to that diversion and building of Chambers Lake Dam and the Sky Line Ditch, this land had not reached a very great stage of development.

Development under the two canals in the two different localities up to the present time is indicative of future development. It is typical one I think.

2959 Poudre Valley has not reached its height of development under canals. Have been over land included within Greeley-Poudre Irrigation District. It is of much the same character from standpoint of soil and of probable agricultural value, as land under Larimer County or Larimer and Weld canals. Land in Greeley-Poudre District is contiguous to lands under Larimer County Ditch and is nowhere more than few miles from lands under Larimer and Weld Canal.

Agricultural development under Larimer County Canal and Larimer and Weld Canal may be taken as absolutely indicative of future development under Greeley-Poudre system and of land included within Greeley Poudre District, when waters of Laramie River and other streams have been applied. It is very rarely one has land under similar conditions so close to area to be irrigated and thus forms such a complete illustration of what will happen in the future as in this case.

I stated Blackhorn Ranch on Laramie Plains was pointed out to us, at time of making our special trip in 1913, as the show ranch or best ranch on which farming was attempted in Laramie plains region. I had heard repeatedly before that it was an excellent

2960 ranch, but this time we had gone to Agricultural College Experiment Station and we asked officers there as to what was best ranch in valley from their knowledge of the area. We wanted to visit best samples and they stated that Blackhorn Ranch was the best. I do not recall that they mentioned any other in same class. As matter of fact, we visited or went along road from Laramie up the river above Sodergreen's and across country under Pioneer and ranches along ridge and saw a number of those in bottoms of Little Laramie on the way, but there was really not any that we saw or

that was indicated to us, that compared with the Blackhorn Ranch. We visited the Lund Ranch, where a small orchard exists.

Apple orchard on Lund Ranch is right on bank of Laramie River, just at the mouth of cañon, a few miles above Sodergreen's in a well known locality. It was a small orchard. I think 30 or 40 trees as I remember it. They were not in good condition. They had few apples on them. Apples were small. Location of orchard was in a sheltered place, so that it was rather an interesting trial which they were making at the place and was possible because of its location in shelter. Orchard was just an experimental tract, raised more as a matter of gratification or curiosity probably than for
2961 the fruit to be obtained. In the Poudre Valley, by comparison, there are, especially in upper end, some extensive orchards for commercial purposes. Lund's orchard is not commercial and I do not think there is any possibility of such orchards on Laramie Plains. Apples in Lund orchard were little fellows. Trees were gnarled and crooked from winds and were protected by quite a clump of cottonwood and brush just above them, but still the trees were all bending down valley. To the person having the
2962 orchard it would undoubtedly be a matter of a great deal of pride, as it would be to anyone who had accomplished something under great difficulties. Even if the orchard had produced apples for market and they had been sold to people in that community, that would not be taken as index of its becoming a commercial industry in that region.

Observed location of grounds of Agricultural College Experiment Station at Laramie. I was impressed with fact that location was rather favorable example, if anything, of lands under Pioneer Canal. Of course it is close to town and soil struck me as being much more open and porous than most of soil under Pioneer Canal. In addition to that, exposure is to south and southeast. There is a ridge behind it which gives it a little advantage in way of receiving sun's rays. There is also some protection from winds. I was struck by the fact that there was enough gravel to give apparently good drainage over quite a part of the area.

Relative to crop developments indicated by little experimental patches as compared with agricultural development of community from commercial standpoint, I will state that all experimenters know that plat tests, as they call them, are to be taken with a very great allowance as regards yields especially, and to some extent as regards possibilities of growth. At any rate, returns they get from small plats are not apt to be borne out in large fields, so experimenters take these with great deal of caution. At experiment stations crops are grown not for commercial purposes and therefore question of cost is entirely a secondary matter, and labor and care and all other items that go into expense are entirely secondary and could not be taken up in field of practice. That is, they are grown primarily for experimental purposes and not for commercial purposes. Values on experimental grounds can be taken as merely an index of agricultural possibilities rather than probabilities. They give pointers and of course within certain limitations are of great value. Yields obtained from these

experimental plats at any of the experiment stations are not to be taken as indicative of probable yield of like crops under ordinary conditions of farming. They are very misleading in that regard. Misleading in giving an idea that the results they get in yield will be borne out in field conditions. Of course in reporting their experiments of this kind, they report facts as they are, that is, yield they get from size of their tract, very often from 1/100 of an acre, and after determining yield from that 1/100 acre they multiply it by 100 to get rate per acre which is perfectly correct for a deduction but after all is not a very sound basis to estimate yield of a field.

2964 Small tracts shown in Section 31, in what is commonly termed "West Laramie" in Sheet 19 of Exhibit 114 are, generally speaking, similarly situated as to favorable agricultural conditions as the lands in Section 1, shown on same sheet with agricultural experiment station.

Speaking of projection northerly into Canada for similar conditions, climatically, with Laramie Plains, Edmonton, Canada, is more than 6 degrees north of Laramie and Poudre Valley. Comparison I made was in feet and degrees was effect of reducing Laramie by 2000 feet and I also stated that general conditions of Laramie made it comparable with conditions at Edmonton, Canada. Comparison I made was perhaps not quite clear. I stated: 1000 feet in elevation is equivalent to about 3 degrees difference in latitude. There would be a difference of about 330 feet for each degree of latitude. That is not perfectly exact necessarily. If we compare Edmonton, Canada, to Laramie, Wyoming, for instance, Edmonton is at an elevation of 2200 feet and Laramie is at elevation of
2965 7000 feet, practically speaking, so that Edmonton is at 4800 feet less than Laramie. If each thousand feet is equivalent to a difference of 3 degrees in latitude, then 4800 feet would be equivalent to about 14.4 degrees in latitude. So then, if Laramie could be reduced to 2200 feet lower elevation, it could be put 14 degrees further north and have, in effect, same climate as it now has. Its latitude is 41½ degrees, approximately, so that if transported north by 14 degrees it would be up to about 55½ or 56 degrees north latitude. If it then had an elevation same as Edmonton, Canada, it would be at 55 or 56 degrees north latitude and have same climate. Edmonton is at 53½ degrees, so that on that basis Laramie would have a climate of a region 1000 miles north of Edmonton, Canada. The basis of 3 degrees for each thousand feet in altitude is based on comparing elevations of timber line at considerable differences of latitude and is somewhere near correct. If it be considered that difference is 400 feet per degree, that would make it compare almost exactly with Edmonton, Canada, but so far as my observation goes, I would consider that the difference is nearer 350 than it is 400 feet, and that also agrees with observations that I have made at Edmonton, as I have mentioned before. Farming at Edmonton, I think is of better character than I have seen on Laramie Plains and is carried on with far greater success.

2966 Crops raised at Laramie are those that can be grown in a cold climate and that is primarily native hay of some kind. That is true in all parts of the world where similar conditions are encountered. It is true at high elevations. Such regions develop into a hay country or stock country of some kind, of course other local conditions may affect details very materially. With pressure of population, lands will be brought under cultivation that did not pay to farm with population less dense, but even in those cases there are large tracts of land that it will not pay to farm. That is true even in India, that with all their pressure of population there are large areas that are not farmed. It is true in Italy, in France, in England and even, I understand, in China. It is true in eastern part of United States and so, as matter of fact, there is large part of area of United States and in particular states that is really waste land. While there is that pressure towards developing and utilizing lands that have not been utilized before, still it is affected and limited by intrinsic value of lands. It is finally reduced to question of whether land will pay for farming.

2967 General tendency is that of increasing population and cultivation upon already proven good lands rather than settlement of waste lands. That has been the history of the civilized world and especially of irrigated areas. Of course, a few years ago when there were such enormous areas of fine land not taken up, there was a spreading of population into those lands but now the best tracts are largely taken and population spreads into communities that show possibility of development and in most cases those possibilities have already been demonstrated. Their intrinsic value has been ascertained.

Under ideal conditions it would not take quite as much water to produce an acre of alfalfa in Laramie valley as it would in Cache la Poudre valley. Under actual conditions it probably takes more. Poudre Valley produces more alfalfa hay per acre. Net return is more per acre. Cost is very much the same and yield is greater, consequently net return is likely to be greater.

If native hay pays expenses it is, or may be lucrative. If amount that it pays over expenses is small then it means there must be larger acreage for one man or owner to cultivate in order to make it an object. Returns from native hay per acre are much less than in case of alfalfa, but it undoubtedly does more than pay
2968 expenses under fair conditions, and in that sense, may be lucrative.

Have heard irrigated pasturage spoken of by witnesses for Wyoming. This pasturage is raised on land in its native rough condtiion. I have previously mentioned that amount of water actually used was not very much in correspondence with needs of plant. Smoothness of ground, preparation for flow of water so as not to stagnate and stand in pools, physical problem of making distribution even, or as near as may be possible, are matters that control quantity great deal more than need of crop. In cheap land it does not pay to smooth ground. In Poudre Valley they get land fairly smooth and have no depressions. While yield of alfalfa in Poudre

Valley would call for more water than small yield of native hay in Laramie Valley, yet other sources of loss would mean or cause more water to be used per acre in Laramie Valley than in Poudre Valley. Considerable water is required to irrigate this pasturage and there is a great deal of waste. Water is wastefully applied. Re-
2969 turn is small compared with amount of water used.

Several times as much water is used in Laramie Valley on average as is used in Poudre Valley per acre. This I should judge from observations I have made in Laramie Valley as compared with measurements we have in Poudre Valley. Several times as much water is required to produce an acre of irrigated pasturage in Laramie Valley as is required to produce acre of potatoes, sugar beets, cabbage or onions in Cache la Poudre Valley.

As live stock country, Laramie Plains is best adapted to pasturage and developing stock during summer and fall and letting other localities finish the stock. It is a country that does not seem adapted to produce forage to any great extent and winters are cold. It is largely true that Laramie Plains has been devoted chiefly to producing the animal and that it has been finished and fattened
2970 ready for market in the Cache la Poudre Valley. The large amount of hay in Poudre Valley has made that a place of winter feding of lambs especially, and to some extent, cattle. In Larimer and Weld Counties in Poudre Valley, there are vast areas of land equally capable of producing live stock in summer months as are lands on Laramie Plains. This is unirrigated land. The alfalfa raised under irrigation will finish much greater number of animals than can be produced in region immediately tributary to valley, so that for past 20 years Poudre Valley has been importing sheep especially from New Mexico, Arizona, Montana and Wyoming, and fattening them during winter, feeding them alfalfa and corn which is purchased from Nebraska and Kansas, and finishing several hundred thousand lambs for market.

Sugar beets and other similar tender crops will never be produced commercially on Laramie Plains. They may be produced in small tracts occasionally. Turnips and rutabagas are a
2971 hardier crop. They are grown in Poudre Valley to very small extent. They are grown as matter of stock feeding and kind of a side issue. Very small acreage is ever devoted to them. They have not entered into general agriculture of valley but have been cultivated in small tracts from time to time.

Potatoes of early variety will have to be raised on Laramie Plains area in order that they may mature before frost. I would not consider that potato raising is apt to be very much of a commercial proposition in that region. There will be tracts where they may grow successfully and produce quite a crop during some years, but one year with another, I would hardly look for much of a production of potatoes in that area.

In number of times I have visited Laramie Valley I have not seen any extensive market gardens, where vegetables, cabbage, onions, lettuce, etc. were raised for consumption of residents of Laramie

or vicinity, and not very much that could even be denominated as small gardens.

Cache la Poudre Valley is exporter of agricultural crops and produce. It exports wheat, potatoes, it produces sugar beets and exports sugar, it exports alfalfa to some extent and mostly in form of fattened cattle and sheep. It exports by-products of sugar industry through same channel of stock feeding, pulp is fed to animals and serves to fatten them. Beet tops are also fed to animals and the syrup to some extent. Most of syrup is re-treated but final residue is fed to animals. They also export fruit, apples and cherries. They export market garden produce, raspberries and at times celery by car-load lots. They export cabbage and onions and a number of similar crops.

Garden products raised near Fort Collins are hauled in wagons to Laramie. There were some gardeners that made regular business of it. Fruits are exported from Fort Collins region to Laramie Plains. There is market there for such material that can-
2973 not be grown in that vicinity.

The canning industry is carried on in Poudre Valley by Empson Canning & Packing Company. There are plants at Greeley, Loveland, Longmont and several other places. Principally peas are canned for export in Greeley factory. Sauerkraut is also manufactured, also tomatoes and cucumbers for export.

As matter of fact there is not one of numerous variety of crops that cannot be grown in Poudre Valley. Longmont community, for instance, early took up peas. Loveland took up raspberries. The same could be done at Fort Collins, Greeley or Longmont but the local nurserymen developed a raspberry that stood up under shipment. Cantaloupe industry developed at Rocky Ford. Same industry could have gone from one community to another.
2974 Onions started at La Porte. Many instances of that kind could be mentioned. Specialty started in each of these communities simply from fact that some man had particular knowledge along one line and gave that his attention.

Laramie Plains region is importer of agricultural products. There is mill at Laramie but apparently supplied by grain raised elsewhere. Grain is milled in transit.

Flour Milling industry is well developed throughout Poudre Valley. There are number of mills and have been from very early days. There are two at Fort Collins and one or more at each of other railroad stations.

L. G. CARPENTER.

Cross-examination by Mr. N. E. Corthell:

2975 I have observed rather than investigated the agricultural conditions of the Laramie Valley, and because of my interest in agricultural investigations, I have made inquiries and watched reports, etc. I have been across the valley on the railroad almost every year since 1890, but made no other trip in that terri-

tory until 1903, when I went over a small part of it paralleling the railroad, and then in 1909 I went from Laramie up Sand
2976 Creek to Sand Creek Pass, and in 1912 I made a number of trips up and down the valley and to the various lakes and reservoirs on the Laramie Plains. In that year I made at least half a dozen trips to different parts of the Laramie Plains requiring perhaps two or three weeks altogether, with an automobile. I traveled over the valley and Laramie Plains at least once
2977 in 1913, and I believe one or two other times also. In 1912 I was instituting some water supply measurements, but was giving attention to all of the general conditions. In a windy
2978 country the surface temperature and the air temperature tend to become more nearly equal than where there is little or no wind. Six or eight years ago I examined the wind records kept at Laramie, but have not reviewed them. My recollection is that the wind movement averages about 10,000 miles a month or twice the movement at Fort Collins, and I would say that the general direction is westerly, judging from the latitude and not from any observation of the actual direction of the wind. I have
2979 made no particular examination of the soil in the Laramie Valley excepting as I have passed over the country and as I have examined the soil survey reports. I would say that
2980 the Blackburn ranch is sheltered somewhat from the north and west, and the slope of part of it to the south and east further modified the climatic conditions. The soil appeared to me to be very excellent, being open and porous and gravelly although not having any large amount of boulders.

2981 I would not say that the rural population of the United States generally has been increasing during the past 25 years. Within the past ten years there has been a decrease in some portions only. There is hardly a place on the Laramie Plains that does not indicate that the farmer has been having a hard time to get along. There is hardly any particular locality which I
2982 would except from this statement, but I do not know the names of any of the places I noted. I recall quite a number of places of this character north of the Little Laramie River under the Lake James Project, and also some abandoned shacks east of Lake Hattie. Excepting places near Laramie City, I recall only one of all of the houses which was painted and I recall none having trees growing around them.

2983 I do not think that the fact that the range land is comparatively scarce in the Poudre Valley accounts for the difference between the industry carried on there and in the Laramie Valley. I do not think that fact has any particular effect on it. It is simply the general conditions. In the Poudre Valley, they have the surplus alfalfa which they raise under the ditches and they bring the stock in and use the alfalfa in the winter. Usually it is the desire of everybody to get as large returns from their resources as they can. If stock is the best way of doing it, they will use stock. It is the economical method to utilize the open range to the fullest extent in raising stock and if there was a larger area of range with re-

spect to the agricultural area in Weld County, you would expect to find more stock raised in that part of the country.

Cross-examination by Mr. John D. Clark.

2984 In my opinion hay is the economical crop raised upon the Laramie Plains, this being due to the soil and climatic conditions and not to any lack of enterprise on the part of the inhabitants. I presume that the raising of hay produces some net return, but the large size of ranches would indicate that the return is not very great. While some farmers favorably located
2985 and favored with some exceptional season might procure a net return and perhaps a large net return from some special crop, on the whole no other crop would now pay or could be looked to in the future as a paying crop. I do not believe that the returns from the growth of hay would justify any greater investment than the present investment, and I should say that the present investment is now larger than the hay return would warrant. The only practical method of irrigating hay land in that region is through flood irrigation, and taking present conditions as a whole, the methods of irrigation now in use on the Laramie Plains are the natural methods. It would require careful investigation to determine whether the return which can be secured from the hay crop would justify the additional expense of preparing the ground so as to economize in the distribution of water. If they were pressed to save water there would be some effort to prepare the ground, as the present method of distribution is very wasteful. I do not
2986 know whether, if they were to go to the additional expense suggested in the distribution of the water, they could secure a net return upon their crop, but it does appear to me that the land could be prepared at small cost so as to improve conditions at least. By preparing the land I mean to reduce the hills and hummocks. Assuming a net return of from one to five dollars per acre, which is a pretty high estimate, or from one to three dollars per acre, the irrigation investment could not be very large if a net return is to be secured. From the evidence which I have heard in this case I would assume that the gross return from the average hay crop upon the Laramie Plains would be from $5 to $6 an acre. The question of economy of water has never arisen in that valley, and hence the value of water has been very small. I cannot, however, find even to my own satisfaction the answer to the question whether the
2987 net return from the hay crop would justify the expense of reservoirs. It might be justifiable to construct reservoirs of
2988 relatively low cost. There are lots of basins in the region which could be used for reservoirs, but I have no data from which I could estimate the expense. Where a reservoir is to be used for a part of the season only, a larger expense is justified than where it is the only source of supply for the land, as in the
2989 latter case the reservoir safeguards a larger acreage of the crop which depends early in the season upon another source of supply. Of course if the crop is one which requires water only

during a comparatively short period of time, this will be an important condition to take into consideration. The conditions on the Laramie Plains will not justify any large expense per acre. The expense per acre which is justifiable for the construction of reservoirs depends very largely upon a consideration of the value of the
2990 crops and I do not know these conditions sufficiently to make an estimate. One of the objects of my numerous trips to the Laramie Plains was to determine the value of the country from an agricultural standpoint.

2990 Redirect examination by Mr. Delph E. Carpenter:

Weld and Larimer Counties not only raise and develop live stock on their pasture lands, but also finish and fatten sheep and cattle for market, while Laramie Plains regions are devoted primarily to mere growing of animals. If sufficient live stock were raised on the immense areas in Larimer and Weld Counties not under irrigation there would be no physical necessity of going elsewhere for animals, but there might be some economic reason. We have coal close to Denver but we go hundreds of miles for some of it. Other conditions being equal, home product would be used for finishing in preference to going abroad. It would be supposed that difference in transportation would make some difference in favor of local product.

2991 Major portion of acreage in both Larimer and Weld Counties, Colorado, is still in the raw arid state and is pasture lands. I do not recall the total aggregate area of the two counties. Proportion irrigated is relatively small. In addition to the 500 square miles of irrigated land in the counties in Poudre Valley, there is quite an area in Big Thompson Valley that is irrigated.

Fact remains that an acre foot of water in Laramie River when applied in Cache la Poudre Valley will produce greater crop return and help to support greater population than when applied on Laramie Plains region, no matter what the cost of smoothing land in Laramie Plains may be in order that it may be better irrigated.

L. G. CARPENTER continued.

2992 Direct examination by Mr. Fred Farrar:

With reference to water-sheds of Colorado, Colorado practically occupies what is sometimes described as summit of continent. It is situated on Continental Divide so that streams flow from it in all directions for it is not only on the Divide but at the summit of the Divide and its streams run north and south as well as east and west. Wyoming is the only other state that occupies a similar position. There are what might be described as four main stream systems, each with a number of important subdivisions. There are the Platte and Arkansas systems flowing finally into Mississippi River, the Rio Grande flowing into Gulf of Mexico, and Grand flowing into Gulf of California. The Grand and Green and their tributaries and San Juan all contribute to Gulf of California. Prin-

cipal tributary of San Juan in Colorado is Las Animas, with number of smaller ones.

Starting from Continental Divide on north border and going easterly more in detail, we have North Platte and Laramie heading in Colorado and flowing to north. Laramie is branch of
2993 North Platte joining it in Wyoming, near Fort Laramie.

Fort Laramie and Laramie City are very different geographically. Fort Laramie is old post of fur hunting days, while Laramie City is community of recent date.

Starting at almost same place as Laramie and North Platte, is branch of South Platte, the Poudre, and there are other forks of South Platte starting from east side of Continental Divide and running east, all finally forming South Platte in Colorado.

South Platte and North Platte join in Nebraska and finally enter Missouri River. Therefore, North Platte and South Platte are parts of the same stream, the Platte. This stream drains practically all of northeastern Colorado, that is, it drains down to short distance north of Colorado Springs on eastern slope and thence all northeasterly from that to state line. On east side Continental Divide is North Park, which is east of Continental Divide but also west of quite an important range of mountains. There are quite a number of tributaries of South Platte, that is, there are Poudre, Big Thompson, Saint Vrain, Clear Creek, and Bear Creek, as well as South Platte itself and various important tributaries of those streams. It drains large part of eastern mountain slope. South Platte in Colorado, from its initial point to southwest of Denver, flows generally in northerly direction, through City of Denver, until its junction with Poudre River near City of Greeley. From this point it has general easterly direction. In other words, from point
2994 from 12 to 15 miles south of Denver, where stream debouches from hills, down to point near Greeley, stream flows generally northerly and parallel to mountain range. Those tributary streams, Poudre, Thompson, Saint Vrain, Clear Creek, Bear Creek and other smaller ones join it in distance from Denver to Greeley at right angles. Their courses are almost due east. This area constitutes what is generally known as "Northern Colorado Agricultural Area" and is sometimes known as Platte Valley, though more commonly that is kept separate. Courses of these streams are consequence of general geological conditions. South Platte is about 20 to 30 miles from foothills and these tributary streams coming down mountain slope after they leave mountains proper, have quite a fall and thus Platte is very well situated for ease of irrigation and distribution and that tract adjacent to South Platte is practically all under irrigation.

South of South Platte to east border of state are Republican and Arickaree Rivers, also forming part of another stream
2995 system. They are what are described as plains streams, that is, for large part of their course they are dry. They do not run much water except at heavy storms, in which case they have floods. As a whole, they are small streams. They become perennial streams for distance after they cut through layer of water

bearing rock in one place and both after and before reaching that point they are not perennial streams. These two streams finally join in Kansas. Republican River is one of streams which form Kaw River near Junction City, Kansas. It is long but of small importance. Republican and Arickaree in Colorado are streams of practically little importance and quantity of water they carry is very indefinite. They are minor streams. Their heads are on plains low down and thus they do not have advantage of mountain water sheds. They therefore flow in aggregate a moderate amount of water but run-off of plains area is much smaller comparatively speaking than run-off of mountain areas. Rainfall in eastern Colorado is not so very great. As you go east into Kansas and Nebraska rainfall increases. They do not have more rainfall than in mountains, but more rainfall than on plains near mountains. There is very little agriculture by irrigation from Republican and Arickaree Rivers. There are a few ditches and a little irrigation but it is insignificant.

Arkansas River watershed comes south of Republican and Arickaree. That includes practically all of remaining portion of Colorado east of main range. That is not Continental Divide. It lies west of San Luis Valley. Both Arkansas and Rio Grande watersheds are east of Continental Divide.

2996 Arkansas River starts near Leadville, passes out of mountains at Cañon City and then crosses plains to state line total distance of about 350 miles in Colorado. It drains very narrow watershed in mountains. It widens out on plains and includes practically all of southeastern Colorado. Headwaters of Arkansas in mountains are very close to headwaters of South Platte, that is, they practically start at same point, one flowing to northeast and one flowing almost south.

The Sangre de Cristo range of mountains constitutes divide between Arkansas and Rio Grande watersheds. It is one of highest mountain ranges in state although not a part of Continental Divide.

There are no important tributaries of Arkansas River in mountains. There are several draining small areas near Leadville and a few small ones between there and exit from mountains, but, as a whole, its watershed is narrow, only 18 or 20 miles wide in mountain region. Area drained by Arkansas on plains is very large, extending from Divide near Palmer Lake north of Colorado Springs, almost east to state line and south of Arkansas River nearly to interstate line in Las Animas County. Extreme southeastern

2997 corner of state is drained by Canadian River.

Pueblo, an important Colorado city, is located on Arkansas River. There are number of smaller cities. Colorado Springs is on its watershed, so are Leadville, Salida, La Junta and various others. Headwaters of this stream and South Platte are little west of center of state.

Cities of Fort Collins, Boulder, Denver, Colorado Springs, Pueblo and Trinidad are all near eastern foot of mountain range. Fort Collins is about six miles from foothills. Denver is a little further. Colorado Springs is a little closer. Pueblo is perhaps a little further

from what we ordinarily call foothills, so as a whole, they are at junction of mountains and plains, or nearly so. This line of cities running north and south very closely defines in an uncertain sort of way boundary between plains area and mountain area. Plains start a little east of these places.

Rio Grande River drains San Luis Valley and flows south from Colorado into New Mexico. Principal source of Rio Grande, however, is New Mexico. Nearly all water coming from that region instead of Colorado, that is Conchas River. Rio Grande in Colorado was known to Spaniards as Rio Del Norte. The area
2998 which Rio Grande drains below is about 2000 miles and stream flows thereafter in Gulf of Mexico. San Luis Valley in Colorado is very large flat, an ancient lake bed, covering about 4000 square miles. In addition to that, there is considerable drainage area to west, running up into mountain areas. They are of different character from mountainous areas to north.

San Luis Valley is surrounded on all sides by mountains. Rio Grande leaves San Luis Valley through deep cañon in basaltic sheet rock several hundred feet deep. Average altitude of valley about 7500 feet.

2999 San Luis Valley cannot be compared topographically with Laramie Plains region, except in one way. It is valley surrounded by mountains. San Luis Valley is very smooth without irregularities on surface. It is flat and does not have elevations or variations and almost no drainage channels so that it is not cut up. As to altitude and being surrounded by mountains it is similar to Laramie Plains. San Luis Valley is protected on north and open to south, while Laramie Valley is protected on south and open to north. Laramie Plains is about 300 miles north of San Luis Valley. That distance is equivalent to considerable difference in elevation which comes of difference of latitude. Laramie Valley would have to be lowered about 1200 to 1500 feet to make up for difference in latitude and to give it similar climatic condition.

Rio Grande River in Colorado runs in generally southern direction and that prevails until river reaches El Paso, when its general direction is southeast.

3000 Streams thus far mentioned are in eastern part of state and east of Continental Divide and flow into Gulf of Mexico.

Rest of state drains into Pacific watersheds, that is, into Colorado River and its tributaries and thence into Gulf of California. West of San Luis Valley comes San Juan River system and tributaries and draining southern part of Colorado, Archuleta County, La Plata, San Juan and a portion of Hinsdale and Mineral Counties. Principal tributary stream is Las Animas and there are number of secondary streams parallel with Las Animas and joining San Juan in New Mexico. General course of these streams is influenced by topographic and geological condition of that portion of state. Streams flow south passing across state in rather long narrow valleys and then joining San Juan short distance within New Mexico, where general course of stream is nearly west. That country, as a whole, is rather

open mesa or plateau country. Valleys are narrow as distinguished from those on eastern slope.

Dolores and Mancos Rivers lie west of the San Juan River and tributaries, and are large tributaries of the Colorado. The Mancos and its tributaries run nearly northwest and the Dolores runs more nearly north and paralleling state line for distance of about 80 to 100 miles.

3001 That mining region generally known as San Juan District is at beginning of this group of rivers, that is, of Las Animas and Dolores Rivers and also of Uncompahgre River which runs into Gunnison and then into Grand. There is a group of high mountains at head waters of these streams which include many silver mining camps.

There is on that watershed in southwest a condition which has led to taking water across divides. I refer to irrigation of Montezuma Valley near Mancos, where water is taken from Dolores River. General conditions there are such as have been described sometime before in the examination, where there is fertile valley without much water supply and another stream nearby which could be diverted by a tunnel. Two tunnels have been taken through the intervening ridge.

Grand River and tributaries lie to north of the Dolores. Grand is principal river running west and joins Green in Utah to form Colorado River. Headwaters of one branch of this stream are near Leadville, Colorado, and another fork heads just across mountain range from North Park and some of its tributaries interlace with those of Poudre which runs into Platte and all of various tributaries interlace with tributaries of all other streams running easterly including Arkansas River, Rio Grande and

3002 other various tributaries of South Platte, so there are quite good many places where water is taken across divide from one side to another, according to local needs and conditions.

Water is taken across divides above Montrose north of Ouray and also at headwaters of Arkansas River and at headwaters of Platte and of almost all of these streams.

Grand River drains country which is largely mountainous, though Rocky Mountains proper perhaps could be considered as terminating not far from Glenwood Springs. Range is granite mass of mountains, while to west it is stratified formation and largely mesa country of high plateaus with narrow valleys. Outlying land is flat with wide table lands and very difficult ascents and ranging from several hundred to several thousand feet above general valley of stream. There is complete absence of flat plains country you find on eastern slope. Available land on western slope for irrigation is confined to narrow strips along these streams. In order to go outside pumping is required and areas that are available are small. There is considerable pumping started from streams but as great deal of land runs up to several thousand feet above stream, most of pumping is out of question for irrigation.

Territory west of Glenwood Springs is mountainous so far as topographical conditions are concerned, but is broken up

3003 with flat topped mesas. Formation is stratified rather than granitic. It has been formed of deep layers of strata and these

have been broken through and washed out. As these strata are very largely shale, it makes very precipitous slopes which are difficult of ascent. Capping is of harder rock.

Principal tributary of Grand River in Colorado is Gunnison River which in turn has Uncompahgre as a tributary. These are streams I mentioned sometime since in my testimony relative to inter-watershed diversions under United States Reclamation Project. Waters are taken from Gunnison River into Uncompahgre and there are also some private diversions from some branches of Gunnison and Cimmarron, which is one of its tributaries, into tributaries of Uncompahgre.

North of Grand River are various tributaries of Green River. It is in extreme northwestern part of state and starts in Wyoming. It crosses state line several times and finally passes through western Colorado for a short distance. Yampa and White Rivers are two important tributaries of the Green and drain most of northwestern part of Colorado, counties of Rio Blanco, Moffatt and Routt. Some tributaries of Yampa start in Wyoming and flow southward and some start
in Colorado and run across into Wyoming and come back
3004 again. Interstate line is not very far from divide.

We have streams starting from Colorado and running in all directions. Streams descending to north such as branches of Platte, North Platte and Laramie. Streams descending east like South Platte, Republican, Arickaree and Arkansas. Streams running south like Rio Grande, San Juan and tributaries. Streams running west like Dolores, Grand, White and Yampa.

Colorado occupies such a position that water runs in all directions from it and no other state except Wyoming is similarly situate. While these streams run north from Colorado into Wyoming, there is another elevation of general mountain range further north in Wyoming in Big Horn Mountains and near Yellowstone National Park, so that streams from Wyoming likewise run to north, east, south, southwest and west, running from Wyoming into Montana in case of Yellowstone, Big Horn and Tongue Rivers; running east into South Dakota in Belle Fourche River; running east into Nebraska in North Platte and several other streams and running south into Colorado in case of Crow Creek, Lone Creek and various tributaries of South Platte. These latter streams are small but they supply considerable water at their headwaters. They are used for irrigation in Wyoming and also for ditches in Colorado and run into South Platte River. There is also Dale Creek and Fish Creek that interlace with headwaters of some tributaries of the Laramie. These lat-
ter streams join Poudre. On the west and southwest of
3005 Wyoming are Snake River and Green River and their tributaries, running from Wyoming into Colorado and into Utah and Bear River on the west which runs into Idaho, so that situation of Wyoming is very analogous to situation in Colorado as regards relation to adjoining states.

Streams coming from Wyoming into Colorado do not compare in size with North Platte and Laramie Rivers running from Colorado into Wyoming. None of them are of any size except Little

Snake and Green Rivers. The Green River runs from Wyoming into Utah, then into Colorado.

There is decided difference between eastern and western slopes of Continental Divide from the stream standpoint. East of mountains are Great Plains. These have general slope to east and while there is depression or kind of trough next to foot of mountains, yet as a whole slope is to east. Plains are rolling with long smooth ridges almost free from rocks so that it is all an arable country and capable of agriculture if water supply is sufficient. At foot of mountains we have narrow valleys and that prevails in all the mountainous region from Glenwood Springs east to near Denver and north of San Luis Valley. In southwestern portion of state and west of Glenwood Springs is general mesa country with flat top mountains and narrow valleys.

The western portion of Colorado has relatively abundant water supply with small area of land for irrigation, while eastern part of state has very large area of land capable of irrigation as com-
3006 pared with its water supply.

Our plains streams are of a very different type from streams in eastern states. With stream running through humid country, at least in eastern United States and most humid countries, streams steadily increase. Country through which it runs is contributing to stream. That is not case of our plains streams—after they leave mountains. We cannot say that these plains streams are
3007 actually draining the country in sense of deriving supply of water from the country most of time. These streams are naturally decreasing instead of increasing as they go away from the mountains. They have always done so from earliest period of discovery and, inasmuch as these conditions have existed for a long period, undoubtedly it has always been the case. Same general fact is observed with all rivers under similar conditions, for instance, in Asia, Algeria, Egypt, China, Turkestan and in some parts of Russia, in some parts of France and Spain and elsewhere, where there is considerable supply of water from mountains at the source of streams and then where stream passes tract or region where rainfall is small. In a humid country rain fall is larger than ordinary evaporation from ground. Ground is more or less saturated, marshes may exist and at any rate there are springs to great extent, and these continually contribute accretions to the stream.

In country like Colorado, as has already been described, water has been long distance from surface of ground. Rainfall has been little more than sufficient to supply evaporation and hence surface of soil has been dry and free from water and instead of contributing water to stream it has absorbed water from stream and supply of water in streams has steadily decreased and sometimes disappeared entirely as in case of Arkansas and South Platte Rivers in early days and which is still true of Republican and many other like streams.

Effect of irrigation is to fill soil so that it leads gradually to change of conditions and bringing about of condition that is much like eastern country. This naturally exists in the mountains,
3008 where rainfall runs from 16 25/100 inches and over, and streams there increase in size from starting point down to

point of leaving mountains. After leaving mountains they have decreased in size as water has been taken up by sands and stream has contributed to ground water.

As we pass further east we get more rainfall, as in Kansas and Nebraska and even in eastern Colorado, and there these streams again begin to increase. That is shown to be the fact in the Arkansas River and was described in testimony and exhibits shown in the case of Kansas versus Colorado.

Effect of irrigation is to produce an artificial condition, in a measure and to a limited extent, similar to natural conditions in humid country. Soil has an excess of water as compared with evaporation, and that excess is constantly draining off and forming a stream in the irrigated country. The excess is applied to irrigation and it leads to almost same condition, so as matter of fact, it has followed that these streams near mountains have become perennial streams. A great many of these dry gulches or draws that were formerly dry, except for rain storm, have become running streams at all seasons of year, and in many cases, streams of considerable size, and have become sources of water supply in irrigation season and ditches have been constructed from them to utilize that water in a great many cases.

3009 South Platte and Arkansas Rivers, before beginning of irrigation, became practically dry down at and near east line of state of Colorado during low flow, because of fact that there were no accretions from any source to the arid soil through which they flow and evaporation rapidly diminishes the quantity of water as it passed down. That as irrigation has been practiced on upper reaches of stream, soil becomes saturated and there is constant return of water from soil under irrigated districts back to stream. This has had very marked effect in gradually extending flow of water in stream. There has been very noticeable change, all within memory of our older citizens. That is, Poudre River, for instance 30 years ago, had practically no increase from mountains to Greeley. When I first measured it about 25 years ago, there was less than 100 cubic feet per second coming in from other than surface channels, and that has in meantime more than doubled. South Platte likewise from Denver to state line, has general increase of from 1000 to 1500 cubic feet per second. It used to be dry at times before irrigation was practiced, somewhere in vicinity of Fort Morgan. There are records of that kind. Fort Morgan is about midway between eastern edge of mountains and east line of State of Colorado. Stream is known to have gone dry at Fort Morgan in early days. Now, in non-irrigation season, instead of drying up, it has become stream of considerable size running 800 to 1500 cubic feet per second during winter months, where even within my knowledge, it was insignificant. As matter of fact, there is substantial flow of water even during

3010 dry summer months, not only at Fort Morgan, but at Julesburg and Sterling. During summer months they take out good deal of water and a good deal enters stream again within short distance. Possibilities of irrigation at Fort Morgan and lower down stream, have developed by these conditions and by this return water.

First time I was at Fort Morgan some 25 years ago, there was very little water for area then under irrigation. In the meantime that area has been very largely increased, large areas have been brought under irrigation near Sterling and Julesburg and now there is in winter months, a good deal of excess water going to waste. That has been brought about largely through storage and application of Platte waters near the mountains. This has extended the fringe of the irrigated area, gradually and constantly.

Same rule prevails on Arkansas River. Records were found that river had been known to be dry as far west as Rocky Ford before irrigation was begun and repeatedly in sections between there and Lamar and practically to state line. Application of water for irrigation has made that pretty constant region. River has never become dry of recent years, unless it be just at vicinity of some headgate. It is then found to run a large stream of water lower down. It is true that application of water in Colorado, particularly from conservation of flood waters in reservoirs and its later application, will in time make possible irrigation on lower reaches of South Platte and Arkansas in States of Nebraska and Kansas, which, without irrigation above could not be irrigated. There is constantly working
tendency, a condition that gradually develops and within my
3011 own knowledge has been quite marked.

This condition is to those who have made a scientific study of it, an absolutely well established fact. It is known in all regions where irrigation is practiced. That has been true in India, France and Spain and it does not require much consideration to see that these conditions are universal. Even 35 years ago, Major Powell, who had a remarkable grasp of conditions in general, and remarkable foresight, called attention to benefits of intercepting and storing water and using it on Upper Platte in order to make Lower Platte a perennial stream and to obtain greatest use from that stream.

The use of water on the upper reaches of the stream, soil and climate being favorable, is absolutely necessary in order to get fullest use of water and from standpoint of ultimate development, that is only way it can really be obtained. I have always considered that it had been fortunate in development, especially locally, that so much irrigation had taken place near mountains.

3012 Have made scientific measurements of return seepage water from irrigated lands. I have carried on for many years measurements of this character and I presume, roughly speaking, have probably covered what might be termed some 8000 or 10,000 miles. It has required that distance of traveling along stream to make measurements as we went. These have included South Platte and all of its tributaries, Arkansas, Rio Grande, Uncompahgre and some other minor streams. Longest series of these measurements have been on Cache la Poudre River.

First seepage measurement was made in 1885 by Mr. R. S. Nettleton and Mr. B. F. La Grande. At that time they had commenced to notice fact that water in stream was increasing and that dry arroyos were running water. This measurement in October, 1885, was first measurement of kind to ascertain that fact. Total increase

from cañon to Greeley was 48 cubic feet per second. Another measurement of similar kind was made in 1889. From 1890 I took up measurements. A detailed summary is given in Bulletin 180 of the Colorado Experiment Station, No. 2, for Cache la Poudre and there is detailed total of series of 36 different measurements con-
3013 tinuing each year from 1890 to 1910. During later years there is quite marked increase over those of early years. Increase very frequently exceeded 200 cubic feet per second from cañon to mouth of stream. This same increase has been noticed outside. Increase that is recorded is that which came into stream and does not include seepage water intercepted by ditches and reservoirs, which was quite a considerable amount, and if it had been measured and counted it would have increased this sum in later years a good deal, so that represents change from about 50 cubic feet per second in 1885 to 200 or 220 about 1910, and indicates corresponding increase in actual water that is coming from saturated soils in valley, due to application of water in valley. It is really less than real increase, because later years good deal is taken into reservoirs and ditches that does not show up in this summary.

These measurements were made by measuring flow of stream at mouth cañon and deducting all diversions from stream, deducting accretions to stream from any other stream and then taking balance representing increase from return or seepage water. It is substantially increased from percolating sources. In some cases draws were supplying water that could not be identified as seepage, whether or not such was case was determined by temperature. Difference in temperature between natural and seepage water was quite easy to determine.

3014 Return or seepage waters do not appear immediately upon application of water to given tract of land. It takes quite long time, depending upon distance of land from stream, character of sub-soil, opportunities it has for returning, water applied and other factors. It may take number of years as has already been testified in this case; considerable time may be taken in addition to velocity, to filling up sub-soil. If sub-soil is filled, it takes quite long time for water to pass any distance; One mile per year is fair statement but would be modified by character of gravel and other conditions.

Flow of seepage water shows some response to high precipitation or high application of water in any one year, but variations are smoothed out and reduced, so that constant increase in rain fall or water might be shown in long continuous slow increase in seepage flow.

Increase of return flow of water in Poudre River was 500 per cent from years 1885 to 1910 inclusive. If there be some allowance made for fact that first measurement was preliminary, when conditions were not well understood, it is still safe to say that gain has been something like three times.

Made comparison of percentage of water diverted from Poudre River and used for irrigation which finds its way back to stream, some years since, at a time when seepage was not so great as it is

now and result of that will be applicable to present time with
3015 slight modification. In an investigation published in 1896 and known as Bulletin No. 33, I made comparison between water that came back as seepage and water that had been applied, and reached conclusion at that time that 30 percent. of water applied returned to river. This conclusion is given in Conclusion 15 on page 62 of Bulletin. At that time, water that was being applied to outer areas was not showing up at stream as much as it was later and returned from seepage as shown in tabulation in Bulletin 180 has been increased since that time as a whole. Taking conditions together, I think it is safe to say, that amount that comes into river is something more than 30 percent. It was constantly increasing, so that it is something above that, but I have not made comparison recently. It is above 40 percent. and may be even more. At that time practically all the seepage water came into Poudre River above its junction with South Platte. There was some seepage beginning to appear below that point. At present time there is considerable seepage entering South Platte below mouth of Poudre, and in making such comparison this amount should also be included as the return from application of Poudre water. Main body of irrigated land on South Platte in portion known as Lower Platte, is practically disconected several miles from main body of irrigated land in Cache la Poudre Valley. There is no continuity of irrigated area
3016 running right down Poudre Valley and thence down Platte River. There is quite a strip of barren land on both sides of South Platte below mouth of Poudre. On other hand body irrigated land in Poudre Valley is contiguous to body of irrigated land above mouth of Poudre, though perhaps land on south side of South Platte near Poudre is an extension of Big Thompson area.

Speaking of Upper Platte and tributaries, you have general body of land more or less irrigated, extending up and down Platte River from above Denver to mouth of Poudre and this area is increased by irrigation of Valleys along streams coming in from west, Cache la Poudre, Thompson, Saint Vrain, Clear Creek and some of smaller streams. That body is disconnected from irrigated section of what we term Lower Platte commencing down in Fort Morgan region and running thence to state line.

Similar set of measurements were made in South Platte River for quite a number of years. Return and seepage water is in-
3017 creasing there more rapidly, if anything, than on Cache la Poudre, for while in 1890 quantity at Iliff, just beyond Sterling, amounted to about 150 cubic feet per second to that point from mouth of Poudre, in fifteen measurements in 1903 it amounted to 720 cubic feet per second. This measurement was taken at Iliff. I took that because in 1890 Iliff was last point of observation. In 1902 it was 760 cubic feet per second. Iliff is in Logan County some 10 or 12 miles down stream from Sterling. It is about 50 miles up stream from point where river crosses interstate line.

Measurements of South Platte show definitely loss in stream of this character,—that is, stream like the Platte or Arkansas, and change

in conditions with subsequent irrigation. In first 5 or 6 series of measurements, made from 1890 to 1894, South Platte River gained from mouth of Cache la Poudre down to Iliff; from Iliff down to state line a decrease shown by series of measurements, with flow stationary at Fort Morgan. Last measurements show an increase down to state line. Since first measurements were made, there has been considerable increase in vicinity of Sterling as well as Fort Morgan and quite an area has been brought under irrigation from Iliff to state line, especially adjacent to Julesburg, so that return water from these sections begins to show and river is increasing all way down to state line, while years ago it was decreasing part of that distance. I might say that percentage of return on Platte River was probably more than on Poudre.

3018 Similar series of measurements was made on Arkansas River, something like 12 or 15 series of measurements from Canon City to state line that shows increase in series of years, starting in with something like 150 cubic feet per second in earlier measurements and becoming near 400 cubic feet per second in last few years. Greater irrigation is permissible in Lower Platte district owing to application of water during past years in Cache la Poudre Valley. This is particularly true in Fort Morgan area. That application in turn may make permissible an increased irrigation as you pass down river. It has already had that effect. I should say that this measurement I spoke of on Platte is simply from mouth of Poudre down to state line. It does not include increases that have come from irrigation above mouth of Poudre either from Platte itself or from tributaries, Big Thompson, Saint Vrain, Boulder Creek and other streams. A similar rule applies to that, so that as a matter of fact, water is more than used over. If, for instance, one half of 40 per cent returns and is used again, then 40 per cent. of that second water would be repeated and so on till it is used. Everyone acquainted with Platte Valley for past twenty years has seen effect of this increase and those who have had occasion to know valley in anything more than purely limited sense, know effect that has come from this seepage water. Stream therefore that used to be low in fall and winter now is high in winter at times when ditches are not taking it out and then reservoirs get abundant supply of water in winter. In fact are getting more than they can use. Some change is taking place not only down at state line, but beyond, and these streams are becoming perennial, where formerly they were dry.

3019 Familiar with valley of Laramie River in Colorado. Same general laws of return water prevail there. Water applied to land would return, or portion of it, quickly to stream, as gravel is large and distance small, so that as valley is narrow and material mostly coarse, water that returns could be expected to return in rather short time. Hence effect of irrigation in Colorado would probably be to retard fall of stream but not to keep stream so uniform as in case of Platte or Poudre, where water is applied so much further from stream. Water in Laramie valley in Colorado must all be applied within very short distance from stream. This

3020 narrow valley would hasten the return. Coarseness of gravel would probably increase amount of return. Water

would flow faster and easier and come back quicker and in probably greater quantity. A large part of that valley is of coarse gravel.

On Laramie Plains same laws of return prevail, but conditions are somewhat different and thus consequences are to some extent different. Some of that soil is fine, adobe clay, with fine deposit that is almost impervious to flow of water, or, at least, soil is penetrated slowly. I think this applies to both subsoil and top soil. Along bottoms there is coarser deposit. Water goes through fine material very slowly and instead of flowing one mile per year as it might in ordinary soil, it will not flow near that distance. That means that soil becomes saturated with water, greatly supersaturated and becomes seeped and that kind of soil becomes alkaline and gradually gets into bad condition. Some water will get back into stream in course of time, but unless there should be layers of gravel under neath surface it would mean that surface would be water-
3021 logged with water on surface, forming pools and evaporating. On Laramie Plains in course of time they will either have heavy returns of seepage water to stream or land will become supersaturated, marshy and the soil will become almost impassable. In some places it may be drained. So far as conditions can be foreseen, they will either have heavy return flow or drainage will be necessary.

In clay soil of any character, water goes through much more slowly than through sand and gravel; through gravel faster than through sand; through sand faster than fine sand and then with mixture of clay or finer particles to fill up interstices, or presence of fine clay or sedimentary deposit, soil will be practically impervious to water. Water will go through any soil, but instead of going through at rate of 10 or 30 feet per day, it may at times not go more than one inch per day. This makes condition of almost water tightness. Very slight stream will therefore furnish more water than soil can transmit and that must of necessity be forced to surface.

Soils of that kind, wherever located so that water comes down upon them, nearly always becomes swampy, water-logged, perhaps impassible and generally show patches of alkali. These soils also generally contain large percentage of alkali. Have observed
3022 seepage lakes on Laramie Plains lying under Pioneer Canal and extending up river in general direction from Laramie. They indicate that basin was pretty nearly water tight; that amount of water that is coming into those basins from rainfall and seepage from above is more than evaporation has taken care of. Indications are that water level has been rising in many of them.

My designation of soil on Laramie Plains differs from other witnesses simply from places to which attention is directed. There are places where soil is coarse, largely along river bottom. On some of uplands surface soil is coarse but soil beneath seems to be very tight and almost impervious, and, as far as seepage is concerned, sub-soil cuts more figure as a rule than surface soil. I was rather thinking of it from that point of view. There is large strip of land running west and southwest from Laramie, for instance, along road, that has fine deposit and it is shown in case of even slight rain that

it becomes very difficult to travel. It is slippery. The soil
3023 I have in mind is extremely impervious. You will find great many other tracts of same character of soil all over valley. Much of that soil has been deposit- probably from ancient lake and is very fine. Coarser soil has come from streamdeposit.

Regardless of seepage or return flow, drainage is almost necessary in any irrigated area. In many places there is natural drainage. Drainage must be either natural or artificial. If drainage is done directly, the water becomes then available for use.

Intercepting drainage water by building ditches for using this water in irrigation has been prevalent in Poudre Valley for 25 years. There are great many ditches that are called "seepage ditches," that is, they depend for their supply entirely upon water that is received from seepage. I made attempts some years ago to ascertain number and I know there were then a great many. Number has been increasing since. In some cases these ditches were constructed more for purpose of getting water for use in irrigation than for drainage of lands. In a few cases the water was incidental and in many cases water and drainage was a combined object.

Dividing Colorado into two classes,—plains and mountain lands, and assuming mountain valleys to be mountain land, the mountain area exceeds the plains area in Colorado. Mountain area is about 2/3 of state. Even if high mountain tracts, such as North Park, Middle Park, South Park and San Luis Valley, were included as plains lands, greater area of state would still be mountainous. Proportion would not change much. Plains area would increase from about 1/3 to 2/5.

In the bulletin from the census of 1910, which I have before me, area of Colorado is given as 66,341,120 acres.

Irrigated acreage in Colorado is 2,792,032 acres as given by census of 1910.

4.2 per cent. of state is irrigated, practically one part in twenty-five.

Colorado exports a good many products and has done so
3025 for a number of years. It has been importing other products. I have not had occasion to look at those figures for some years and would have to give very general statement. Exports are wheat, potatoes, sugar from sugar beets, alfalfa, alfalfa seed, peas, cattle, sheep, fruit, apples and peaches, cantelopes and melons. During portion of year state imports peaches, apples, cantalopes and melons. It imports dairy products to considerable extent, and poultry, although it produces them to considerable extent. It has been increasing its production of hogs and hog products. Same is true of dairy products. Think it imports more than it exports of dairy products. When I spoke of exporting sheep, I referred to finished product. It brings lambs in and exports practically same number, but very much increased in size and weight. It also produces large number of lambs on its own grazing ground.

Colorado leads other states in production of beet sugar. It is foremost state in United States in number of factories and in production of both beets and beet sugar.

3026 Beet sugar is produced in the South Platte Valley east of the Poudre as well as in the Poudre Valley. In South Platte Valley there are three factories. Arkansas Valley has six factories. There is one factory in San Luis Valley at Monte Vista and one factory at Grand Junction. Outside of Poudre Valley in northern Colorado, there is one at Loveland and one at Longmont. There are 17 sugar factories in the state.

Colorado exports agricultural products of much greater value than it imports. Fruit section of Colorado is on Western Slope. There is also fruit section at Cañon City and a great many areas along foot of mountains, but not so well known.

Poudre Valley area is ahead of other irrigated sections of Colorado in point of development. It was settled as a whole earlier than most other irrigated sections of state and it has been 5 to 10 years in advance of irrigation developments of other areas.

L. G. CARPENTER.

Cross-examination by Mr. N. E. Corthell:

3027 Alamosa, in the San Luis Valley in Colorado, about 280 miles south of Laramie, has an elevation of 7550 feet as against an elevation at Laramie of 7100 feet. There has been extensive irrigation development in the San Luis Valley, the 3028 irrigated area now amounting to about 300,000 or 400,000 acres. The irrigation development commenced about 1850, but the principal part has been in the last 30 years, being more rapid in the first part of this period than in the last part, a great deal of the land that was settled in the early days having been abandoned. How this abandoned area compares with the annual reclaimed areas I do not know. The census reports a total area 3029 of 361,840 acres irrigated in the San Luis Valley in 1909, and the geological survey report gives a total irrigated area of 298,650 for the same region in 1899, and 143,801 acres in 1889. The irrigated land which has been abandoned is valley land, abandoned on account of seepage. Some of the seeped land in the San Luis Valley is of an impervious character, as is true with respect to some land in the Laramie Valley in Wyoming, although this is not the predominating character of that soil which for 3030 the most part is porous and gravelly. The principal crops in the San Luis Valley are wheat, oats, and in recent years field peas. Efforts have been made to grow sugar beets and potatoes, and there is a beet sugar factory which was operated in 1912 3031 and for a few days in 1913. It was constructed about 1910, and has experienced considerable difficulty. Field peas were first planted about 1895, on account of the poor success with alfalfa, and they are now grown quite extensively. In some years potatoes have been grown to quite an extent, at least enough to ship 3032 out. The complete result of this crop I do not know, but it has not been a very great success in some of the recent years, and I do not know whether the area given to potatoes has

been increasing or decreasing. As to whether farming in the San Luis Valley is generally considered successful, you can get reports of all kinds.

While the seepage and return flow of water in the Poudre Valley constantly varies, the constant tendency is to increase from one period to another. In the first two or three years following the commencement of the work, there was no great degree of accuracy in the measurements, but after that and commencing about 1885 we were more careful, and attempted to have all ditches in the section measured shut down. Commencing in 1891 this was not done, but the ditches were kept at a uniform flow which was measured and taken into account. The amount of return flow throughout the irrigation section of the Poudre River at the date of the measurement nearest to October which was covered in each year measured, in cubic feet per second was as follows: October, 1885, 48.02; October, 1889, 98.97; October, 1890, 100.79; October, 1891, 79.53; October 1892, 96.28; November 1893, 98.68; August, 1894, 118.17; October, 1885, 162.47; November, 1896, 65.27 (one section of the river omitted); October, 1897, 120.79 (one section omitted); August, 1898, 125.18; September, 1899, 134.12; September, 1900, 110.02; July-August, 1901, 167.50; July, 1902, 119.43; August, 1905, 186.37; September, 1904, 173.49; September, 1905, 180.83; September, 1906, 216.13; September-October, 1907, 203.15; September, 1908, 225.32; October, 1909, 208.54; October, 1910, 159.72.

Our method of measurement was to divide the stream into sections of such length as could be covered within one day, making allowances for the inflow and outflow and then measuring the stream itself. At one time I thought that the return flow and seepage was increased during the summer months, and that may have been the case at that time, but it is not true now, as the return flow has been very largely equalized as the irrigation has extended several miles from the river, over which distance it would take two or three years for the water to travel.

The measurements of the return flow into the South Platte River were made from the mouth of the Poudre to Iliff, fifty miles west of the state line, or to the state line. For the years 1891, 1894 and 1895, it appeared that there was a loss from Iliff east, and it is a fair assumption that this was a constant loss existing in former years. In 1889 the gain between the mouth of the Poudre and Iliff due to return and seepage flow was 217 second feet. In October, 1890, it was 165.5 feet; in October, 1891, 285 feet with a loss of 10 feet from Iliff to the state line; in October, 1893, 254.7 feet; October, 1894, 335.2 feet; October, 1895, 591.1 feet; November, 1900, 861.50 feet; October, 1901, 515.08 feet; October-November, 1902, 762.44 feet; October-November, 1903, 384.22 feet. These measurements were in cubic feet per second. This covered a section of the South Platte River about 100 miles in length running through a district which has been extensively developed during the

past ten or fifteen years, and which has been irrigated to some extent for 25 years.

3041 While seepage conditions are universal in that seepage will always occur and water will return underground to a river wherever irrigation is practiced, the extent of the return flow varies very greatly with the particular conditions. After irrigation has become well settled in the Laramie Valley, I believe the seepage conditions will be substantially similar to those in the Poudre Valley, but the return flow from the uplands in the Laramie Valley will probably be slower than from the uplands in the Platte Valley, as the soil in the Platte Valley is sandier and the return through a gravelly

3042 soil is much more rapid than through a clay soil. In 1896 I reached the conclusion that land in the Platte Valley was furnishing more return water per unit of area than the land in the Poudre Valley.

3042 Redirect examination by Mr. Fred Farrar:

All of San Luis Valley, except river channel and relatively narrow strip close to it, slopes practically toward Alamosa. Sugar beet industry in San Luis Valley has not proven successful.

3042 Climate in San Luis Valley is such that frost may be expected during summer months. They are cultivating field peas in San Luis Valley because they needed a forage crop and also for crop to enrich land, that is, nitrogenous crop. Alfalfa was deep rooted, perennial plant, so that it was not success, principally on account of climate, alfalfa being a lover of warm climates, and because water was near surface. Peas were taken as nitrogenous annual crop. It is small rooted plant and it has improved and helped agriculture there very much.

Production of potatoes in Poudre Valley area has fallen off greatly during last two or three years on account of blight affecting crop. Blight is not limited to the Poudre Valley but extends all over United States. It affects different areas at different times. Celebrated famine of Ireland in 40's was probably due to blight of same character. It is fact that the trouble has been obliterated and that they're securing good crop during 1913. Blight or something similar to it, Rhizoctonia, has affected potato yield in different places or in individual communities from time to time for years, and in Rhode Island especially. Local condition will probably recover and has done so to large degree.

3045 Prof. Fitch, who wrote Bulletin No. 175, to which Mr. Corthell has referred, published in 1910, has admitted that the theories he then advanced were subsequently shown to be erroneous.

3046 DENVER, COLORADO, Feb. 28, 1914.

By Mr. Delph E. Carpenter:

Blueprint map of Wheatland project showing cultivated lands November, 1911, by C. C. Washington, being same Exhibit as Exhibit No. 2 heretofore considered in connection with testimony of

witnesses M. R. Johnson and J. A. Elliott and identified at time of taking of testimony of said witnesses, marked Defendants' Exhibit 2.

(Defendants' Exhibit 2, blueprint map, offered in evidence.)

JOHN E. FIELD, recalled.

Direct examination by Mr. Fred Farrar:

(Panorama album marked Defendants' Exhibit 122, offered in evidence.)

Defendants' Exhibit 122 contains photographs of Wheatland, Laramie Plains and Cache la Poudre districts. These photographs were made in form of panorama so that we could get comprehensive view of district as whole. Panorama camera was used in taking these pictures. It is instrument by which camera revolves around an axis and takes, if required, the entire horizon. It can cover 360 degrees or complete circle and is thus frequently used to give comprehensive view of districts, rather than individual scenes. With these photographs one can imagine himself looking towards any part of the compass. To get really correct idea, unless one is used to looking at this kind of photograph, picture should be turned in form
3047 of circle. Observer should stand at opposite side of circle looking across it. Observer then looks in direction in which camera was pointed while picture was being taken.

In panorama Photograph No. 1 in Exhibit 122, picture should be turned in form of circle and two fence posts at either end of picture made to coincide, then observer standing opposite road shown in panel No. 2, looking across diameter of circle formed by picture, would be looking north. Observer could then move to right, looking across picture, he would be looking west, and moving still further to right and looking across picture he would look down second road due south. In this way person can realize direction and get himself properly orientated to view the photograph.

These panorama photographs were taken on a continuous sheet. Negative was continuous. For purpose of easier handling, prints were subsequently divided into panels and mounted.

Photographs vary from arc of 120 degrees to a complete circle. Panels are numbered beginning at left. Figures at top of picture indicate number of panel. These figures are put on for ready reference in describing pictures and what they were intended to illustrate.

Fourteen panorama photographs in Defendants' Album
3048 Exhibit 122, numbered 1 to 14, with a legend preceding each picture. Photographs in Wyoming are numbered from 1 to 5 and those in Colorado from 6 to 14.

Photographs were taken to present to the court as clearly as possible, general appearance of districts under discussion. For that purpose Exhibit 122 should be taken in connection with photographs shown in Exhibits 115 and 116, 119, 120 and 121.

Exhibits 115, 116, 119, 120 and 121 give individual views, while these panorama views, Exhibit 122, connect up these views, as it were. Details could be studied from exhibits mentioned, while gen-

eral idea of country can be better obtained by examination of panoramas.

First photograph in album, Defendants' Exhibit 122, is panorama taken about 2 miles southwest of Town of Wheatland. It covers 360 degrees or complete circle. Entire horizon is covered and embraced within boundaries of picture. It was taken near east quarter corner of Section 24, Tp. 24, N., R. 68 W. It is almost in heart of older developed district of Wheatland tract, showing farms which have been, generally speaking, longest cultivated. An examination will show area covered by panorama to be that portion lying between Colorado & Southern Railroad tracks and Chugwater Creek. This appears by Exhibit 2. Panel No. 1 is looking in northwest-
3049 erly direction from point where picture was taken. Extreme left of panel covering portion of town of Wheatland, in background. Road shown on Panel 2 is running in due northerly direction. This panel, as well as Panel 1 is looking north across Laramie River, and highlands in background are on north side of Laramie River. Panel No. 3 is taken looking almost due east. Highlands on east side of Chugwater Creek are shown. Panel No. 4 swings more to south. Panel No. 5 is looking almost due south as shown by road, which is same road, except looking in oposite direction as that shown on Panel No. 2. Panel No. 6 is looking in westerly and southwesterly direction and Panel No. 7 completes circle. Portion of town of Wheatland being again shown on extreme right end of panorama.

Picture taken August 7, 1913. It shows that alfalfa was largely in stack. First cutting having been made sometime previous and part of second cutting is in stack, as will be shown by close examination of photographs. Stacks close to each other being of different color, showing more age on one than other. Alfalfa is also shown in bloom in near foreground, second growth. Improvements are shown on nearly all panels, farm buildings, trees and other improvements surrounding them. This is a good district. While it
3050 *it* is further north than Poudre Valley, it has about the same elevation. Season is of course shorter than in Poudre Valley. Though it does not compare very favorably with Poudre district, it compares most favorably with any district in State of Wyoming and is truly agricultural country. This picture, if placed in form of circle, indicates just what man would see if he stood at point where camera was placed, without changing his location, merely turning completely around. This panorama is of same size as original negative. It has not been enlarged or changed. The same is true of all of these panorama photographs.

Panorama No. 2 is another portion of Wheatland area and lies south and west of town. It was taken near south quarter corner of Section 28, Tp. 24 N., R. 68 W. August 7, 1913. This panorama also covers complete circle or 360 degrees. Panel No. 1 is looking little southwest and shows Laramie Mountains in background. Rise of ground west of Sybille Creek. Elevated ground under words "Laramie Mountains," not mountains themselves, but elevated ground between mountains in territory covered by Sybille Project on west

side of Sybille Creek. Panel No. 2 looks little north of west
3051 and shows farms and improvements and cultivated areas in Sections 28 and 29, Tp. 24 N. R. 68 W. On Panel 2 considerable good development is shown. Alfalfa is in stack and residence and improvements are also shown. In extreme background of picture in Panel 2, appears Laramie Peak. It is so labeled. This is one of landmarks in that district. It is a high mountain and North Laramie River heads in that vicinity. Laramie Peak is about 30 miles in air line from point where picture was taken. Panel No. 3 shows one of laterals serving land of Wheatland District. It will be observed from waves shown on water that it is running at very great velocity. This great velocity is possible by reason of considerable amount of gravel in soil which remains in bottom of ditch and prevents further erosion. This condition is common to ditches in this district. Velocity keeps bottom and sides of ditch scoured from silt and seepage from them is very great. Waste from them in consequence of such condition is excessive. Road shown on Panel 2 and also its continuations on Panels 3 and 4, is almost in east and west direction and practically follows section line between Sections
3052 21 and 22 on north and 27 and 28 on south. Land in immediate foreground in this picture is not under cultivation. Picture was taken near edge of cultivated area and in newer portions of district. Larger part of land in this district is not cultivated. Cultivated land may be seen in distance on several panels, improvements and hay stacks on horizon being on land lying almost due south of town of Wheatland. Panel No. 5 shows character of native vegetation and uncultivated character of part of land. Panel No. 7, looking to south and west, shows no cultivated land whatever.

Area in newer tracts in Wheatland district, that is, Bordeaux and Sybille or Cooney Hill tracts, is not as good as that shown on Panel No. 2 of this picture. There is greater amount of waste land. It is more difficult to get water to it. Sybille tract lies somewhat higher and is more remote from railroad. It is not as good as Wheatland tract but might be called fair. Bordeaux tract on other hand, I would classify as very poor land on account of great expense of providing ditches and laterals. Land is cut by draws, arroyos and swails. Bench lands are flat but of small area. On this tract, development will be in small areas along draws and in scattered tracts on bench. It will never be cultivated in anything like contiguous body. I, from my experience, would judge that from 50 to 60 per cent of land embraced in Bordeaux tract is not available for cultivation under present economic conditions. The arroyos and ravines
3053 are quite deep. Ground is very rolling. Gulches have cut through mesa and time has smoothed down roughness and it is not exactly an arroyo country but steep and hilly.

Panorama No. 3 was taken August 8, 1913. It covers something over 180 degrees of arc and was taken from edge of highest bench lands just above north canal of Lake Hattie outlet. It is south and west of Laramie and approximate location of camera was near west quarter corner of Section 17, Tp. 15 N. E. 74 W. Panel 1 is looking almost due east and does not reach quite far enough north to take

in locality of Laramie. It does show hills or mountains to east of Laramie. Road in Panel No. 2 is leading due south going practically toward Laramie River. Panel No. 2 shows canals, North Canal of Lake Hattie outlet and also Pioneer canal. Panel No. 3 is looking south and west towards Jelm and Sheep Mountains. Panel No. 4 is looking practically west. Northerly end of Sheep mountain is shown, which is point where Little Laramie River enters Laramie Plains proper. On all of these panels, the canals, Pioneer and North Canal and Lake Hattie outlet are shown, except on Panal 4 Pioneer Canal is not shown. Photograph shows that soil in vicinity is gravelly as do also all excavations for
3054. Lake Hattie outlet in new canal. Canal below it is Pioneer. It is old canal said to have been constructed in 1879.

Series of lakes or ponds are shown lying under these two canals and running in line along center of picture. These are natural depressions in surface of ground where water has collected and in case of areas where no water is shown they are commonly called alkali bogs. It is wet ground where soluble salts have been left on surface after water has evaporated. Lakes are principally fed by waste and seepage water from various canals traversing district, particularly from Pioneer Canal. Effect of North Canal of Lake Hattie outlet has not been felt as yet, but after it has been operated for awhile one can predict with reasonable certainty that very large area lying under it and near foot of slope from which picture was taken, will be practically one continuous alkali lake or bog.

Small clumps of trees, five on Panel 1, four on Panel 2 and none on other panels, are, without exception, on Big Laramie River. Group of trees on line between Panels 1 and 2 being Hutton Grove on Big Laramie River.

3055 Absence of farming is shown by this view. Note absence of characteristics which are always found in agricultural communities in those portions of United States where rectangular system of survey has been made. One expects, in looking over farming community, to see checkerboard system, to see cultivated areas in rectanguar shapes, which are distinctly and plainly outlined by different colors of different crops. Grain and alfalfa and hay crops forming contrasts which show plainly, but there is an absence of any such appearance on this picture. Such farming as is done, is in such irregular manner that it does not show. In fact there is no continuous farming in this district and it is well illustrated by that absence of checkerboard appearance which one always expects to see in a farming country.

Picture was taken August 8. Having been informed that Pioneer Canal was constructed in 1879, 35 years ago, it seemed incomprehensible that with an abundant water supply, with ditch already constructed, so little progress along farming lines had been made, except, of course, when we stop to consider climatic conditions and soil. In my experience, I think I have never seen district other than this where water had been provided for even ten years, much less 35 years, without development being practically complete.

3056 Panorama No. 4 was taken from knoll in Section 25, Tp. 15 N. R. 76 W. and Section 30, Tp. 15 N. R. 75 W., It was

necessary in order to get anything at all, to get on some elevated point, and it was for that reason that I took these pictures from edge of highest ground. Picture taken August 8, 1913. Panorama covers about 240 degrees of arc and shows area between Pioneer Canal and Laramie River, and area north of Pioneer Canal and south of Lake Hattie inlet and Big Hollow. It also covers territory which lies east of Lake Hattie inlet from Big Laramie River. Panel No. 1 is looking almost due east and little south. Right edge of Panel No. 2 is looking almost due south towards Boulder Ridge. Panel No. 3 Jelm Mountain is shown and I have indicated on Panel 3 approximate location of mouth of Big Laramie Canon. This is in vicinity of Woods Landing, Wyoming. In Panel 4, Sheep Mountain, Lake Hattie and mouth of Little Laramie Canon are shown, also on Panel 4 one can observe Lake Hattie Dam and water in lake itself. This picture also shows prevalence of waste lakes where seepage and waste water accumulates and shows generally character of country. Body of water shown in foreground in Panels
3057 2 and 3 is waste lake.

The four photographs, two of Wheatland area and two of Laramie area, were taken by same operator and camera on succeeding days.

Photograph No. 5 is view of Little Laramie Valley. It covers about 240 degrees of arc and was taken from north end of Sprague Lane. Road shown on panel 2 in which word "South" is written, is Sprague Lane, which is part of Lincoln Highway, a transcontinental automobile road. On Panel No. 3 location of Jelm Mountain, Sheep Mountain and Little Laramie Canon and Filmore, Wyoming, are indicated by arrows. On short Panel No. 4, Centennial Mountains are indicated. Panel No. 1 is looking down Little Laramie River towards Two Rivers, which is junction of Little and Big Laramies. Immediate foreground shows ditch. Further down in bottom land or to south there appears meandering channel, it is one of channels of Little Laramie River. Looking
3058 closely, further across picture, there are other channels which are parts of Little Laramie. One is called Brown Creek, but it is merely a channel of Little Laramie River. There is practically no difference between this creek and river itself. Sprague Ranch appears in foreground. Pole corrals joining large log barn indicate that it is stock ranch.

Taking view of valley shown in Panels 1, 2 and 3, it is evident that agriculture is entirely native hay. At time picture was taken, greater part of hay had been put up. There were some tracts that had not been cut. Road called Sprague Lane appears to be graded. This is what Mr. Corthell in his cross-examination of Mr. McAnelly termed a turn pike.

Roads of Laramie Plains are naturally fair, but there are not many of them. They run diagonally generally across country and in general direction in which one wishes to travel and in that respect they differ from Poudre Valley where section lines are followed almost entirely. Roads generally speaking follow natural topography

of country in Laramie Plains, almost without reference to section lines.

3059 Measured two fields of native hay, which we considered quite a little better than average. Made measurements with Mr. Woodhall and Mr. McAnelly on Little Laramie River valley. Mr. Bath, owner of these meadows, informed us at time we made measurements, that no hay had been hauled off place, which was another reason for selecting these places for measurements. .6 of a ton of native hay per acre crop production was demonstrated by these measurements. He probably fed some during time he was cutting hay, but he did not haul away any. From that measurement in an estimate, I judge, in fact I am quite positive, that average production of native hay in Laramie region along both Big and Little Laramie Rivers, will not average over one half ton of native hay per acre per annum.

Panorama Photographs 3 and 4 in particular show considerable portion of Pioneer Canal and area under it. The Eaton or Larimer and Weld Canal in Cache la Poudre Valley is of about same date of construction as Pioneer Canal. Also Evans No. 2 which takes water from South Platte River between Denver and Greeley.

3060 Also Northern Colorado Irrigation Company's canal, known as High Line, taking water out of South Platte south of Denver with date of priority January, 1879.

There is no comparison between development agriculturally under any of these Colorado canals and the Pioneer Canal. Under any canal in northern Colorado of such a date, where there is bare sufficiency of water, lands are practically all cultivated and well developed. Under Pioneer Canal, as I stated, there is comparatively small percentage of land under cultivation.

Wheatland area which is shown in part in pictures Nos. 1 and 2 in this album, is later than the Pioneer Canal but the country is much better developed than under the latter canal principally on account of difference in climate. Soil is in my opinion, somewhat better on Wheatland tract, but, particularly on account of climate at Wheatland, they can grow crops and make a profit. It is due to climate that there is such a lack of development on Laramie Plains. These two districts are both watered by same stream. In air line they are not very far apart. Wheatland area is something over 2000 feet lower. I think there is no comparison be-

3061 tween the development of the two districts, Wheatland district looks like farming country, Laramie plains area does not.

Panorama Photograph No. 6 of Exhibit 122 was taken in Poudre Valley, in Colorado. It is panorama of 300 degrees arc, taken from point about two miles west of Ault, showing lands under Larimer County Canal. District shown in this photograph is one of rather recent development. Photograph taken August 5, 1913. Panel No. 1 is looking west and northwest towards Larimer County Canal, which is situated in vicinity of trees in background. Lands appearing above line of trees and beyond trees are portions of Greeley-Poudre Irrigation District. Panel No. 2 is looking in northerly

direction as indicated by arrow on road. Panel No. 3 is taken looking in northerly and easterly direction and on right edge towards town of Ault. Panel No. 4, was taken looking in southerly direction. Panel No. 5 is in southerly direction. Road indicated on Panel No. 5 being southerly continuation of same road indicated on Panel No. 2. Districts are illustrative of what I meant by term "checkerboard" appearance of country. Fields of different crops are shown in rectangular shape. Different crops indicated by difference in color, grain, potatoes, beets, etc. and alfalfa, giv-
3062 ing appearance of neatness and of systematic development. Trees in background are some of them along laterals but groups of trees are generally speaking surrounding farm buildings and improvements.

Panorama Photograph No. 7 covers about 120 degrees of arc and shows cabbage and sugar beet fields and also town of Ault in background. This area is irrigated from water from Larimer County Canal. Picture taken August 5, 1913. Crop of cabbage in immediate foreground. Little further back, crop of different color is sugar beets. Also in reference to this picture, panorama No. 8, which follows, was taken from square white building shown in Panel No. 2 of this photograph. Next picture was taken from building shown in this picture.

Panorama Photograph No. 8, taken August 5, 1913, covering about 240 degrees of arc, shows part of residence section of town of Ault, Colorado, and view would partly lie to southwest and northwest of town and along Larimer County Canal. Panel No. 1 is looking in southeasterly direction towards town of Eaton, approximate location of town being indicated by arrow. Eaton is about four miles. Panels 2 and 3 are taken in southwest and westerly direction and cabbage and sugar beet crops shown on Panels 2 and 3 are same shown in Panorama Photograph No. 7. Crop in near fore-
3063 ground on Panel 2 is onions, this was not visible from other direction in Panorama Photograph No. 7. Highway on Panel No. 4 is looking in northerly direction towards Pierce. Panel No. 4 also shows number of residences of town. Area shown in this photograph is one of later developments under this canal.

Panorama Photograph No. 9 taken August 5, 1913, covers something like 250 degrees arc. Was taken from point about one mile southwest of Pierce, Colorado, and shows land brought under cultivation quite recently. This land under Pierce Lateral of Larimer County Canal, constructed during last four or five years. This land was of desert character prior to being brought under ditch. It was regular plains country characteristic of eastern Colorado and poor grazing land. On Panel No. 1 in background is shown buildings of Pierce and road in Panel 2 is running in due easterly direction. On Panel 3 location of town of Ault is shown by arrow. Panel No. 4 is looking in southwesterly direction. Lands of Greeley-Poudre
3064 Irrigation District lie just north and east of lands shown in this picture and immediately joining. This photograph illustrates very well response of land under irrigation, except that it would give better idea had we been able to get further back and show

contrasts between uncultivated territory and this cultivated land. This well illustrates what can be done in course of three or four years, where conditions are favorable for farming under irrigation. Year 1911 was one of comparatively short water supply and scarcity, 1912 was about normal in supply and 1913 was excessively dry. This shows what was done in the very dry year of 1913.

Pierce Lateral was constructed to irrigate land above old land of Larimer County Canal. Land in this district has developed towards north. One traveling back and forth between Cheyenne and Denver, if he passed over that district about two years since, would notice that every time he made a trip the irrigated and cultivated lands had been extending further north each year. Pierce Lateral merely extends area under Larimer County Canal little further north. Town of Pierce, as shown in picture, is in extreme southerly edge of the Greeley-Poudre Irrigation District.

Picture can be said to fairly illustrate probable result of application of water for irrigation of lands in Greeley-Poudre Irrigation District. The areas are identical, but we might expect even better results. It is hardly likely that in beginning they will meet in Greeley-Poudre District same adverse conditions of shortage of water that they have in district shown in photograph. This photograph is not designed to show typical lands of Poudre Valley, but lands that have just been brought under cultivation and which are immediately joining lands of the Greeley-Poudre Irrigation District. It is typical of development of new lands.

Photograph No. 10 is panorama covering complete circle taken August 5, 1913, from roof of Eaton Sugar Factory at Eaton, Colorado, and shows portion of lands in that vicinity. Land shown is irrigated by Larimer and Weld Canal. Panel No. 1 is looking in westerly direction and residences of town are shown in picture. Panel No. 2 is looking in northerly direction and shows line of Union Pacific Railroad running in direction toward Ault, Pierce and Cheyenne. Panel No. 3 looks in northeasterly direction; structure in foreground is beet pulp silo near sugar factory. Sugar factory was not in operation at time picture was taken. Campaign had not opened yet. Panel No. 4 is taken in an easterly direction and shows feed yards of Bruce G. Eaton. In immediate foreground is field of beets close to factory. Object in immediate foreground is chimney of factory. Panel No. 5 is looking in southerly direction and again shows line of Union Pacific Railroad looking toward Lucerne, Greeley and Denver. South point is indicated by arrow put on panel. Panels 6 and 7 are looking in southwesterly and westerly direction. Small rectangular yards or fields shown on Panels 2 and 3 to left of pulp silo are feed yards. These are yards where beet pulp is fed to cattle. Picture as whole shows number of trees, some along ditches and laterals. They were set out artificially. Where trees are grouped, rather more dense, they, generally speaking, surround farm buildings. Residence portion of town of Eaton is concealed by trees in panel No. 1. "Checkerboard" appearance is quite plain on
3067 this picture, excluding feed lots, etc. It is especially apparent in Panels 4, 5, and 6. Reason it does not show so

plainly on Panels 1, 2 and 3, is because it is looking diagonally across country.

Area under Larimer and Weld Canal, Eaton Ditch, is same from standpoint of time of beginning of development as that under Pioneer Canal. Canals are practically same age and opportunities for cultivation, as far as point of time is concerned, are about the same. Development under this canal was hampered by litigation relative to water rights for considerable time.

Panoramic Photograph No. 11 covers 240 degrees of arc and was taken on sections 7, Tp. 7, N., R. 67 W. at point nine miles east of Fort Collins and shows newly developed land under extension of North Poudre Canal. Older developed lands are in distance in background. Panel No. 1 shows southwesterly direction; Windsor Reservoir indicated by arrow. Panel No. 2 is taken in southwesterly direction and shows Timnath Reservoir location, indicated by arrow. Panel No. 3 is in westerly direction, looking toward Fort Collins. Approximate location of city indicated by arrow. Panel No. 4 is taken in northwesterly direction and on this panel location of town of Wellington is indicated. Land in foreground is irrigated by North Poudre System. It is of very recent development. Tract shown in foreground has not been under cultivation more than three or four years. Picture, taken as a whole, does not give fair representation of older developed districts of Poudre Valley. It gives idea of newer developed districts.

3068

Panoramic Photograph No. 12, covering 160 degrees of arc, was taken August 6th. Land is under Greeley No. 2 Canal. It was taken on southwest quarter of Section 20, Tp. 6 N. R. 65 W. Shows sugar beet and oat fields. Photograph shows development under older canal. Age of district is somewhat indicated by size of trees.

Panoramic Photograph No. 13 shows area just acress road from area shown on Panorama No. 12. Covers about 120 degrees arc and taken August 6, 1913. Shows southeast quarter of Section 19, Tp. 6 N. R. 65 W. being south of Lucerne, Colorado. Oats and wheat fields are shown. Approximate location of town of Lucerne is indicated by arrow on extreme left. Two lines of poles along highway throughout this photograph are telegraph, telephone and power lines. Power lines run through this district to supply light and power.

Panoramic Photograph No. 14 covering 240 degrees of arc, was taken from roof of warehouse at Lucerne, Colorado, August 6, 1913, and shows portion of territory at Lucerne irrigated by Larimer and Weld Canal. Panel No. 2 is looking in northwesterly direction and shows cultivated fields. Panel No. 3 is taken in northerly direction and shows Union Pacific Railroad running north. Approximate location of town of Eaton is indicated by arrow. Water tank of Eaton Sugar Factory is shown on horizon near center of Panel 3. On this panel is also shown in foreground one of potato cellars that are common throughout this district. Another potato cellar is also shown on Panel No. 4. Panel is taken in easterly and notheasterly direction.

3070 Finding suitable location from which to take photographs was the principal difficulty encountered. It was difficult to get location where all features that were desired could be shown to best advantage. I drove over district before taking photographer out, trying to locate advantageous position, where it would show the Wheatland country in particular as a whole. I was desirous of taking eastern portion of tract at Wheatland, as being older and better developed, and also taking western portion of tract as showing newer country. In Panoramic Photograph No. 1, for instance, I selected this point because it was highest ground in that vicinity and showed country in every direction. If I had gone further south it would not have shown north country and vice versa. I made attempt to take photograph from the small building shown on left side of Panel No. 2 of photograph No. 1. We could not get photographer up there to place his instrument, that might possibly have been better location although it would not have shown the south country as well. In selecting position for picture in western portion of Wheatland tract, I first attempted to take it from water tank to west and northwest. It would then show uncultivated area in near foreground although other directions of compass it would have shown cultivated areas. This picture was also selected because ground sloped in different direction and we were on high point to take in greater scope of country. It shows also uncultivated area as well as cultivated.

Aimed to get typical pictures in taking the Wyoming photographs. In taking two Wheatland photographs, aimed to get best in older and better cultivated districts and also best in newer portions of district.

Have examined legends preceding each of these photographs in the album Exhibit No. 122. They are correct.

Have lived in west all my life. My work as civil engineer has been entirely in west. Description and history of process of development under irrigation districts and more particularly the Wyoming areas involved in this controversy, the Poudre Valley and other areas in Colorado, which will illustrate development and reasons for lack of development are as follows:

3072 In beginning agricultural development was encouraged to large extent by necessities arising naturally in a new country and farms were first located along river bottoms, where natural growth of grass was such that hay could be cut. First development on Big Laramie River and on rivers in northern Colorado were about same time, I would say that first period extended into middle seventies. Returns from these river bottom farms were gratifying and profitable, and in these districts where these farming operations were carried on, territory cultivated or farmed gradually extended. In Laramie Valley they did not extend beyond river bottom, while in valleys or streams in Colorado, as soon as bottom lands were fully occupied, farming operations extended to higher or bench lands. Settlements along rivers formed a nucleus for further development and farms were extended out of river valley proper to higher lands. Canals in Colorado were extended and

new ones of course were built to cover high lands. This nucleus settlement along river bottoms, was very important, because it furnished feed for horses and people who developed higher lands. In Colorado, returns from development of higher lands were so satisfactory, that we see a continuous extension of canals and extension of area, until practically all area available has been exhausted. As population became more dense in stream areas of northern Colorado, people there seeking new territory scattered over almost entire west. They went to Wheatland and aided in development of that district; they went on to North Platte in both Wyoming
3073 and Nebraska and aided in development of that country. We also find people from this section in Sheridan County, Wyoming.

Development also spread from Poudre Valley down South Platte and lands there were put under cultivation gradually. During this wide spreading out of course areas in original settled district were gradually filled in and made almost one solid farm.

Arkansas Valley development was somewhat more recent in the main, than that of northern Colorado, similarly the San Luis Valley and the Grand Junction Country that was somewhat later. In Grand Junction country they did not really get into development until the eighties. Still later, people spread south as far as extreme southwestern portion of Colorado in the Montezuma Valley. Within recent years, Colorado people have gone into Idaho and into Alberta. The influence of mining has been mentioned by some writers as being very great and being the incentive for our development. This is true if limited to our earliest development. In sixties and early seventies mining was largely at head of Clear Creek and Boulder Creek and we find farm produce from Boulder Valley and from Clear Creek and some from Thompsons contributing to support of mining camps. Little, I think, if any, produce of Poudre Valley was shipped into mining camps. There have been a few efforts at mining in Larimer County, but there has been no successful mining at any time on Cache la Poudre. There are practically no mines or mining camps in that country today. There has never been what would be called mining camps. Same is true of Big and Little Thompsons. And, except on south fork of Saint
3074 Vrain, there has been no mining. That would be Boulder in County.

With discovery of Leadville, attention of people was distracted from farming operations and much of brain and brawn necessary for farming development was withdrawn from farms. If Leadville had any influence on development of farms in state it was confined to Upper Arkansas Valley and San Luis Valley. South Park of course contributed considerable in way of hay to Leadville district, but as far as northern Colorado is concerned, I think discovery of Leadville was really a detriment and money discovered in Leadville was largely spent in Denver, Pueblo and surrounding towns. South Park and San Luis Valley have developed much more slowly than northern Colorado. This I think is due to altitude and climate and notwithstanding incentive which mining camps might

have contributed, these districts did not advance as rapidly as those in northern Colorado. We find on our farms very few mining men now and little of money taken out of mines has been spent in development of our irrigation.

Money made on farms has been spent in mines. Mining was very attractive to most people and everyone who had a little surplus money was apt to put it into mines. It literally withdrew even capital farms produced.

Influences of mining in development of Poudre Valley was no greater than influence of encampment mining district was on Laramie Plains country or development of coal mines in western Wyoming in vicinity of Hanna. These mining camps here generally developed before railroads came in and produce had to be hauled long distances, so that farming districts in near vicinity of mining camps were those which contributed to mines and were practically only ones that benefited by it.

3075 Northern Colorado was very remote from mining districts, and as consequence, they have furnished little or nothing to them. On Laramie Plains district, coincident with building of larger canals in Colorado, in late seventies and early eighties, Pioneer Canal was constructed. Instead of settlement rather preceding construction, we have here construction preceding settlement, and instead of extension of areas, we have rather a contraction of area on Laramie Plains.

Results apparently obtained on Laramie Plains under Pioneer Canal were not sufficiently profitable to encourage people to go ahead with their farming operations, and while in northern Colorado, especially on the Cache la Poudre, there was tendency to cut farms into small areas, a tendency towards more intensive cultivation. On Laramie Plains, on other hand, tendency seems to have been rather towards enlarging farm unit areas. On Laramie Plains area at present. The Laramie Water Company's system covers new lands and other companies up there, such as James Lake and Talmadge-Buntin District is to take in new lands, notwithstanding that there are large areas of uncultivated lands under existing ditches. In other words investment has been made to take in supply of water and new lands, while there still remains plenty of land under existing ditches if anyone should care to go there and try to farm it.

Produce of Poudre Valley has found its market generally east and outside of state. Thus potato market is in Texas district.

3076 Panoramic Photographs contained in album marked Defendants' Exhibit 122, both as to Colorado and Wyoming areas, were taken in four successive days by same photographer who made an extra effort to take photographs as near same time of year as possible and as nearly, in fact, on same day as possible.

L. G. CARPENTER.

Cross-examination by Mr. N. E. Corthell:

3077 The return flow between the mouth of the Poudre and Iliff on the South Platte River in November, 1896, was 323.50 second feet. In 1897 the measurements were not completed. In November, 1898, the return flow as far as Snyder, thirty or forty miles above Iliff, was 291.88; in November, 1899, 450.54 second feet.

3078 L. G. CARPENTER.

Redirect examination by Mr. Fred Farrar:

Figures I have given to Mr. Corthell on cross-examination are measurements showing gain from mouth of Poudre River to Iliff on South Platte. That when I first took measurements from Iliff on down river to state line, I found loss at state line, covering distance from Iliff to that point. Later on we found that, as irrigation had increased on Lower Platte, in Fort Morgan District and below, there was a gain in water from Iliff to state line. In other words, irrigation has developed gain in river as you progress downward.

1891 was first year measurements were carried from Iliff to state line. In that year there was loss of 9.76 cubic feet per second between Iliff and state line. 1894 is next year in which work
3079 was carried clear to state line. There was loss of 34.17 cubic feet per second from Crook Station east of Iliff to state line. Gain or loss between Crook and Iliff is not particularly distinguishable but seems to have been somewhat of a gain as between Iliff and Crook. Crook is about 15 miles below Iliff.

Definite loss is shown in last part of river but it is somewhat doubtful whether there was in first part from Iliff to Crook

In 1895 there was loss from Iliff to state line of 81.86 cubic feet per second.

In next three years, 1896, 1897 and 1898, measurements were not carried to state line.

In 1899, there was gain of 83.48 cubic feet per second from Iliff to state line instead of a loss.

1900 there was gain of 50.93 cubic feet per second from Iliff to state line and no loss.

1901 there was gain of 15.85 cubic feet per second.

1902 there was gain of 40.60 cubic feet per second.

1903 gain of 48.74 cubic feet per second. A gain for years from 1899 on, and loss in those years where measurement was carried on prior to 1896, that is, in 1891-'94 and '95.

I have no measurements available at state line subsequent to 1903. The only ones I have are those I gave yesterday
3080 and those proof sheets I do not have here.

L. G. CARPENTER.

Cross-examination by Mr. John D. Clark:

3080 The Sixteenth Biennial Report of the State Engineer of Colorado for the years 1911 and 1912, at page 135, contains the following statement relative to seepage measurements:

"The entire absence of so-called 'seepage measurements' in this report will probably be noted. The omission of this class of work has been deliberate and the result of careful study. Not only are the direct results of the measurements themselves open to grave question,

3081 but the elaborate conclusions which have been drawn from them are seriously in error, and have given rise to many false impressions.

The theory of these seepage measurements is based upon several assumptions. These are:

First. An absolutely permanent condition of the stream and its tributaries during the progress of the measurements.

Second. The possibility of differentiating with certainty between the inflow due to surface run-off and that due to the ground water inflow.

Third. That the ground water inflow is due entirely to the application of water to irrigated lands.

Fourth. An assumed accuracy of the measurements themselves which is not justified.

Fifth. The most violent of all assumptions, viz., That the conditions found to prevail at the time of the measurements prevail throughout the year.

None of these assumptions are justified. The river flow is not permanent. The distinction between the surface run-off and the ground water inflow is not well marked, and cannot be accurately defined, and even if it were there is no means of knowing what proportion of the gound water inflow is due to the application of irrigation water. The differences noted in the seepage tables as gains or losses in a certain distance are frequently less than the probable errors of the measurements themselves. And, lastly, there is no justification for assuming that the conditions prevailing in the fall, when the seepage measurements have generally been made, are those of the entire year.

On these grounds it has been determined that the seepage measurements are not worth what they cost, that they show nothing that is not brought out to better advantage by the maintenance of permanent stations, and that they lead to erroneous conclusions in the minds of most people as to the quantity of irrigation water which returns to the streams."

3082 Redirect examination by Mr. Fred Farrar:

Of comments of Mr. Comstock, formerly State Engineer, his statements are made on series of seepage measurements and based on five assumptions which I read. First assumption is an absolutely permanent condition of stream and tributaries during process of

measurement. That assumption is neither correct nor necessary in method I adopted in making these measurements. On other hand rise and fall of river was excluded. In first measurements made by State Engineer's office years ago, some such assumption as that was apparently involved, but whether that assumption was used by Mr. Comstock I do not know. If he did make that assumption, I would agree with him that measurements were not worth taking. But in measurements that have been reported and given just before, fluctuations were given by measuring stream at short intervals of time and short intervals of distance, so that the gain of flow excluding fluctuations of stream was those that we found. Observers were instructed in closing work at night to set gauge at river bank and to make measurement at that place. If stream had risen or fallen during night new measurement was made in morning for new starting point. If river had not changed during night measurement made night before would be basis of determination in our next
3083 section during next day. So these fluctuations were eliminated to pretty complete extent. There were sometimes that certain sections were found to have been subject to fluctuations and those were either rated or excluded as case might be, and these tables referred to, show certain cases of that kind. So that assumption is not a correct statement of the assumptions made by a person who was familiar with actual determination of seepage measurements.

Most of seepage measurements of which I have any knowledge, taken by State Engineer's Department of this state were taken in method I have outlined rather than under assumption made in statement by Mr. Comstock. First few years or some of years before conditions were fully known, I presume measurements were not made with care in detail, but after all that does not vitiate general findings and the conclusions that we found.

Next assumption of possibility of differentiating with certainty between inflow due to surface run off and that due to ground water inflow, is not practically a difficult matter and, in fact in most cases, there is no surface inflow so that there is no differentiation to make and in second place difference between seepage inflow that may have gathered in side channel and surface run off is quite easily determined. You will notice temperatures in tables printed in Bulletins in great many cases. After first one or two sets of measurements, I provided observers with thermometers and temperature of water was taken, which sometimes aided to distinguish. As matter of fact, in most cases, distinction is very easily made and in few cases
3084 that are subject to doubt error which every way is counted would be so very small. There is possibility of surface inflow being nothing more or less than seepage water from side channels. If there were no surface inflow there would be no problem at all.

Third assumption that ground water inflow is due entirely to application of water to irrigation of land is correct. If previous knowledge of district covered by measurements was such that no water from any other source might influence inflow through the ground, then that would be the only source from which we could expect an increase. It is water in the soil and that we know from conditions,

comes almost entirely from irrigation. There have been some places where there was some inflow from natural rain-fall. I have made attempts to measure this at various times from streams reported to be very prolific of inflow like Bijou for instance, and various other streams, and in those cases I found practically negative results. That is, amount of underflow, as it was termed, from natural rain fall was so small as scarcely to be distinguished. Under Colorado conditions, outside of mountains, inflow from streams is not a problem.

Seepage from irrigated lands would be only source of gain in locality such as that between Iliff and state line on Platte River. This is explanation that is evident from conditions; it is a sufficient explanation: it is a cause that is acting, that tends to produce the effect,
and it is a cause also that is sufficient to produce that effect.
3085 At the time of these first measurements quoted, there was practically no irrigation between Iliff and Julesburg. Area given to irrigation there began to increase and amount of water applied to that territory between those points increased and in last few years area devoted to irrigation over there has become quite considerable, so that we have a change in conditions relative to irrigation in meantime simultaneous with effect that is there. As regards rain fall, there has been no material change in rain fall in meantime that would enter into the question. There have been no other changes in natural conditions there that would be of any consequence in that regard. There have been some lands plowed up outside on bluffs, there was an attempt at dry farming and that might absorb a little more water, but that was not such that would cut any figure in this consideration.

On fourth assumption of inaccuracy of measurements, there is no particular difficulty in determining accuracy. That conclusion drawn is not correct under ordinary conditions. It may be true, if an attempt were made to measure those at high water, and it is for that reason that measurements are not taken, for instance, in June and July on the Cache la Poudre, or that at least is one of the reasons. Ordinary measurements may be made to within 2% with current meter under methods adopted. In cases where gain or loss is within less than 2% of amount of measurement, there might be some question then as to exact amount that is thus found, but in most cases that does not enter as question, because discordance that is
found between two measurements which is due to gain or
3086 loss, is more than minimum of accuracy. More than that,
excluding all question as to measurements, it is known throughout all this section, and there are any number of observations to that effect, that when water has been taken out of stream entirely into ditch, leaving none in stream whatever, that in very short distance down stream there is considerable water so that the fact is well known as a fact and purpose and effect of measurements is an attempt to measure amount of this return which everybody acquainted with irrigated section on Platte and Poudre knows is case. Any errors which might prevail in instrument and in record over period of number of measurements are necessarily compensating.

These errors are eliminated if there are any due to that cause. Any individuality on part of hydrographer making measurements, assuming same man made them throughout period of measurements, would probably be compensating in same way, but, as far as the personal equation is concerned, it would be eliminated in measurements of different as well as by same observer.

Fifth assumption, termed most violent of all, is that conditions found to prevail at time of measurements prevailed throughout year. There is nothing in measurements I have given and to which I have testified, indicating I have assumed any such thing.

3087 On contrary in this published bulletin, that has not been assumed. In testimony yesterday I stated my personal conclusion that on Poudre return is now practically constant throughout year; that it was not constant in earlier days and that measurements then made were somewhat doubtful in that regard; but that measurements made during latter years, at different periods of year has indicated that return is practically constant. That statement that it is assumed as constant would depend rather upon person probably who makes it, but it would not be safe to make any such assumption without knowledge of local conditions and that water is applied at some distance from stream. If that is case, that assumption is justified. So that his final statement that none of these assumptions are justified, I entirely agree with. And hence most of the statements made in paragraph following assumptions would be beyond dispute.

United States Government, through the Reclamation Service, has sufficient faith in this system and accuracy of these measurements to carry on investigations of this kind. Department of Agriculture has done so. State of Wyoming has done so. Experiment Station of Wyoming has done so. It has been done in all irrigated sections, although most extensive ones have been made in Colorado and the firs U. S. Geological Survey has made them.

Mr. Comstock was educated as a mining engineer. He was also consulting engineer for The Laramie Water Company of Wyoming. I understand that all their plans and work was subject to his supervision professionally.

Mr. Comstock, while assuming to act as State Engineer of Colorado was at the same time engaged as consulting engineer for the concern most directly interested from plaintiff's side in the outcome of this case. That too at times cause was pending.

L. G. CARPENTER.

Cross-examination by Mr. John D. Clark:

3088 During the first two or three years of my seepage measurements I did not attempt to have all of the ditch headgates shut down, but it was not difficult to ascertain that all of the headgates were kept at a uniform height while a certain section was being measured, as the sections were short, covering 8 or 10

3089 miles, and one or two of them would be covered in a day.

We were disturbed in that way only a few times in a series of 20 years' record. We were generally accompanied by the water

commissioner of the district. A measurement would be made of the river at the head of the section and also at the foot. Sometimes a subsequent measurement would then be made at the head, but this was not general and was not necessary because we traveled
3090 ahead of the flow of the river. The measurements of course were made at such favorable places as could be found, but they compared favorably with the ordinary rating station on the rivers, and I believe the measurements were fully as accurate as measurements at regular river rating stations.

3091 The construction of drainage works has been discussed in connection with several reclamation service projects, but I do not know whether such works have actually been constructed as yet.

3092 Redirect examination by Mr. Fred Farrar:

In Poudre Valley and elsewhere in Colorado, water commissioner frequently accompanied me and assisted in determining these measurements, gave me advantage of identification of headgates and also in keeping headgates at uniform flow. Headgates are not necessarily under lock. In districts where appropriators recognize authority of water commissioner and are law-abiding, they follow his directions without having necessity of lock. They have sometimes locked headgates and in places they find it necessary so to do.

In Wyoming, where, according to witnesses for plaintiff, every appropriator of water and every ditch takes water as they see fit, there might be some doubt involved in the measurements, although if taken with sufficient pains, they might eliminate these uncertainties to some extent.

Redirect examination by Mr. Delph E. Carpenter:

Since my recent examination concerning direction of wind and prevalence of wind in Laramie Plains region, I have consulted data which, at that time, I did not have in my immediate posses-
3093 sion. I find from the records that statements I then made were essentially correct.

Actual miles winds at Laramie averages about 110,000 miles per year. That is practically at I gave it.

That is twice as much wind as at Fort Collins.

Normal direction of wind, as I then stated, is in westerly quadrants. There are three years given in records of Wyoming Experiment Station, giving number of miles of wind for each quadrant, or rather for each octant, and three westerly directions, west, southwest and northwest are rather more than 50% of total number of miles of wind.

During summer months at Laramie, records show month of June, in one case, about average, in another case it is 4% less than average for year and in July and August records show in neighborhood of 10% less.

Station at Laramie is on east side of valley almost at foot of slope of Laramie mountains to east. Principal body irrigated land is west

of Laramie and west of valley and quite a good deal of it has no particular slope but general slope to east. On east side of station
3094 slope is from east towards west, sloping downward toward station.

I have been unable to find wind records for region in Laramie Plains near Sodergreen's or at any other point westerly than area I have given. So far as I know, Laramie is only wind station.

3095 GREELEY, Colorado, March 3, 1914.

HARVEY D. PARKER,

Direct examination by Mr. Delph E. Carpenter:

Reside at Greeley, Colorado, since 1883. Engaged in wholesale produce business since 1892. Am also Vice President of the Board of Directors of Greeley National Bank. During time since 1892 have handled potatoes, cabbage, grain and onions. My firm was Mosher and Parker.

In 1892 four principal firms were handling the farm
3096 produce of Greeley: Greeley Mercantile Company, Farr and Johnson, Strong-Perkins Mercantile Company and W. R. McClelland. There were a few others in smaller outside towns. Business had so increased that by year 1910 there were 30 or 40 men in the business in northern Colorado district. There were that many different firms engaged in that line of business. Each of these firms and parties had numerous men working for them. In year 1910 principal firms were: Greeley Mercantile Company, The Farr Produce Company, Farmers' Mercantile Company, I. Rothchilds and Company, Mosher and Parker, C. Rugh and R. B. Rugh, Potato Growers Commission Company, Greeley Produce Company, Carter and English, Peter Brown & Son, Boile Commission Company and Patterson & Son. There were many other smaller dealers in the business. Number of firms engaged in handling produce in 1910 and increase since 1892 gives idea of increase of business. Potatoes were principal product handled.

3097 Greeley potato district or territory includes the territory under Larimer County Ditch, Larimer and Weld Canal, the Greeley No. 2 Canal and the Greeley and Loveland Canal, all that portion of territory irrigated by those canals east of point between Timnath and Windsor, a little west of Weld County west line. District extends about 12 miles east of Greeley. There were no potatoes produced commercially in upper portion of Poudre Valley or in Larimer County.

Principal firms I have mentioned carried on their business in outlying portions of this potato territory, as well as immediately adjacent to Greeley. Towns or villages outside of Greeley included within the Greeley potato district are: Timnath, Windsor, Bracewell, Farmers Spur, Severance, Ault, Eaton, Lucerne, Evans, Auburn, Kersey and Gill. At all those points we had warehouses, while at other places there were scales and offices.

We have had potato warehouses at all principal shipping points,

for instance, at Lucerne there were two, at Eaton two, at Ault three, at Kersey three, at Windsor two, at Farmers Spur two, at Bracewell one and Gill two. Severance has two.

3098 There are ten principal warehouses in Greeley devoted almost exclusively to the handling of potatoes and onions. Warehouses would run to about following dimensions: 50x180; 50 x 150; 45 x 150; 40 x 50; 40 x 80; 40 x 60; and 50 x 60.

Warehouse 50 x 180 has storage capacity for over 20,000 sacks or 40,000 bushels. Each sack contains two bushels. Warehouses 40 x 60 would hold 7,000 sacks or 14,000 bushels. Other warehouses had storage capacity in proportion.

Potatoes are brought by farmers in wagon loads. Where there is warehouse potatoes are stored in the warehouse and allowed to accumulate and stock was always carried on hand necessarily during fall of year. Through harvest warehouses were invariably filled and shipping took place during rest of season. Warehouses were filled in fall to keep stock on hand in order to ship during

3099 bad roads and bad weather when crop could not be delivered by growers. During fall months we can load directly on the switches at railroad and also accumulate our stock in warehouses. We have had times when we had car shortages when shipments were too heavy for railroads to take care of. During winter months potatoes are delivered by farmers at various warehouses. There is a constant current of potatoes in and out of warehouses during shipping season.

Farmers invariably have potato cellars on their farms, commonly called "dug outs." These would be of average storage capacity of about 6,000 sacks or 12,000 bushels. Farmers store their crop of potatoes in these dug outs directly from field, putting them in loose and re-sacking and marketing afterwards during season. Whole community is in position to store throughout year. Dealers buy directly from farmers. We always made a price on produce and paid them cash for whatever they hauled us. In other words, we were not commission dealers. There is difference between produce buyers and average commission dealer, selling on commission.

3100 Cabbage crop is quite important factor throughout Greeley district. Most of cabbage is buried in ground in field in pits by growers. Cabbage is generally cut and put in windrows and then covered with straw and dirt. If cabbage freezes and is allowed to remain buried in earth so as to draw frost from cabbage, it does not injure it. Cabbage carried over in pits must be left in ground until spring. Some producers store cabbage in dug-outs. Growers aim as a rule to sell cabbage in fall of year before frost.

Onions are important item among agricultural products of the region. We buy onions in fall of year, it has been policy of grower for last few years to sell all of his onions and not attempt to store them. We stored them on second floor of warehouses or in especially dry places. We carry them through shipping season in

3101 that way. March 1st is as late as onions can be carried in storage. After that time they begin to deteriorate very fast.

Warehouses for storage of potatoes and onions are kept at about 32 to 40 degrees Fahrenheit.

Greeley district is exporter of potatoes, cabbage and onions into markets in Kansas, Oklahoma and Texas principally. Shipments are also made to Nebraska, Missouri, New Mexico, Arizona, Louisiana and Tennessee. Shipments have been made to Cuba a number of years. Mosher and Parker and I. Rothschilds and Company have principally handled the Cuban trade. We first started shipments of potatoes into Cuba about 7 years ago. The trade increased. Four years ago we shipped probably 50 or more cars and established our connections over there. I personally established those connections. Went over there to do it but following year we didn't raise so much of a crop. Trade diminished.

3102 Potato shipments have been made as far west as California and as far east as New York.

1892 there were not over 3,000 cars of potatoes shipped annually from Greeley District.

Carload average is 30,000 pounds, 265 sacks ordinarily or in excess of 500 bushels.

1892 there were four principal firms handling produce. Industry increased to such extent that during one year shipments were 12,210 car loads. That would be something over 6,000,000 bushels. Acreage increased continually up to 1898 and from then on held practically constant.

Acreage in 1898 and thereafter about 30,000 acres potatoes. During those years there would be from 26,000 to 30,000 acres of land in Greeley district devoted to active culture and production of potatoes.

3103 During that time there was constant increase of production of cabbage and onions. In 1892 it was small factor in business, but from 1898 on it was quite a factor. Just the rate of increase I could not give. Annual production from 1898 on in Greeley district would be about 500 cars onion and 500 cars cabbage. That is an approximation. Production of cabbage and onions afforded opportunities of shipping mixed car loads of produce, that is, cars of potatoes with small quantities of cabbage and small quantities of onions in each car. There was considerable demand for mixed car consignments. This afforded means of obtaining little better price for potatoes.

Average production potatoes per acre on lands devoted to that industry from 1898 and thereafter was about 100 sacks or 200 bushels. That would be about average production over entire 30,000 acres devoted to industry.

Eating qualities and general appearance of potatoes gave this demand for the Greeley product.

3104 70 cents per hundredweight average price obtained by growers for potatoes handled during years I have been in business. Dealers always figured on margin of 7 cents per hundred. Out of the 7 cents per hundredweight we bore all overhead expenses. So far as price obtained by dealer is concerned, it would be about 77 cents per hundredweight on average. We have seen price here as

low as 20 cents per hundredweight and from that up to as high as $2.00. Fluctuation is caused always by supply and demand.

Texas has afforded market for Greeley potato, because while Texas grows quite a quantity of potatoes, they market their crop and it is consumed very early in season and they are buyers of potatoes after June 1 from some territory. Texas climate does not warrant keeping of potatoes so that they are buying from "hand to mouth" during whole season except in very early spring. The local crop lasts longer in Oklahoma and Kansas. We don't get in so early.

Potatoes of late variety are raised at Greeley.

3105 Early potatoes are raised in Texas, Oklahoma and Kansas. Greeley late potatoes find market after consumption of early potatoes raised in these other districts.

Have become familiar with handling of same class of products in other districts throughout country while engaged in handling Greeley produce. The early potato is invariably a red potato. The red potato goes to the market first. If not all marketed by time white potatoes come on market there is no sale for red potatoes. Varieties raised in Greeley district are white. White potatoes crowd red variety or early potato out of market. Early potato is neither so large or smooth as the late potato. Attempts have been made to raise and market early potatoes in Greeley district for market in fall in competition with the late varieties. The grower and dealer recognize the fact that if they grow a red potato for market it must be marketed early.

If white or late potatoes and early potatoes are put on market at same time, there is no sale for the early variety. Potatoes
3106 of early variety cannot compete in markets of United States with potatoes of late variety. This is true in markets to which we ship and in markets to which produce of practically all western states is shipped. In Greeley district Mammoth Pearls and Rural New Yorkers are principal varieties of late potatoes raised.

Three years ago production of potatoes declined. A blight or leaf roll affected vines and reduced crop very materially. There is a decided increase in crop one year ago over that two years ago and there will be fifty per cent more acreage put in this year than there was last year. 1912 was year of lowest acreage of potatoes in history of Greeley district. Several crops were producing a maximum yield last year. A great many yields are averaging much better than in year 1911. We have every reason to believe that potato in-
3107 dustry will recover its former state. During years subsequent to 1892 and to 1911, we and all other dealers retained regular established line of customers throughout various points of export. It was necessary for us to continue furnishing potatoes to those customers in order to retain their business. We took care of temporary depression in Greeley district by handling potatoes from other territories, principally Idaho. We hope that necessity is temporary and have every reason to believe it will be. The blight affected other district besides Greeley district. Other parts of state were affected; some of territories were as badly affected as in Greeley district. Same

disease, or a nature of disease, affected crops in Idaho, some portions worse than others. It also affected Scotts Bluff, Nebraska, Mitchell, Nebraska, although their crop was limited to early crop and has never been recognized as of any great consequence. Reports are conflicting as to whether or not the same disease affected Wisconsin and other territory. From investigations, we find this same disease has existed at different times at different places all over the world. From best information we can get the effects of the disease are temporary, lasting from three to seven years. In England, which is best
3108 example we have, they claim the country has remained immune over thirty years since they had this same disease. Every possible means for eradicating this disease has been used. Government experts have been brought here. Warehouse facilities for handling this agricultural product are remaining intact during this depression.

Potatoes in Greeley district are raised exclusively under irrigation. Same of cabbage and onions.

Am somewhat acquainted with territory embraced within the Greeley-Poudre Irrigation District. That territory, if irrigated, would be just as prolific as any other territory we have in the Greeley district. It would increase production of potatoes proportionately. We have not sufficiently analyzed soil to know what particular land grows cabbage, onions and potatoes best. Tendency is for heavy land to grow cabbage rather than the lighter soil. The territory included within the Greeley-Poudre Irrigation District, from what I know of it, is more distinctly a potato district.
3109 The territory immediately adjacent to Eaton and Ault is the best portion of the Greeley district for production of potatoes. Eaton is largest shipping point in point of number of cars of any territory. Ault is equally as good only the territory is not so large. The Eaton and Ault territory immediately adjoins the Greeley-Poudre Irrigation District.

HARVEY D. PARKER.

Cross-examination by Mr. John D. Clark:

3109 The average gross value of the potatoes in the Greeley district per acre is $84, with an estimated cost of the crop to the tenant of $45 per acre. The net return is sufficient to make
3110 the potato industry a competitor of the beet industry, the net return exceeding the net return from the growth of sugar beets. During the recent years, when our potatoes have been affected, the trade has taken Idaho potatoes in preference to those we have grown, and if we could offer the same potato that we could three years ago the trade would prefer it to those coming from Idaho.

3110 Redirect examination by Mr. Delph E. Carpenter:

We had great deal of trouble in handling Idaho potato crop last year. It is recognized by Government officials that the disease, known as their dry rot, is somewhat similar to our blight, but in

different form and certain territories in Idaho had serious trouble with the dry rot. This disease comes as a small spot on potato, then in a week there would be two or three spots of same size, sometimes larger. It destroys potato very quickly. Sometimes core of
3111 potatoes will be affected with dry rot and whole potato will go to pieces within a week. We might load a car of potatoes which is apparently sound at Idaho and find them in such shape before they reach their destination that they would ruin the market value. They would not all be rotten but would be in such condition that they could not be disposed of to advantage. We have never had any previous trouble with the blight. We have had trouble at different times with diseases but to no extent until three years ago. We did not give potato diseases so much thought or investigation as we have in late years.

Investigation of late years has proven that some disease is liable to affect potatoes in every region where they are grown. No region is entirely immune.

Seed potatoes planted in Greeley district, other than local seed, is imported from Wisconsin, Minnesota and Michigan. There have been a few seed shipped from Montrose, Colorado, District. We usually prefer to get our seed potatoes from a non-irrigating dis-
3112 trict. Potatoes raised from irrigated seed are inclined to produce runners and where we can get potato seed from what we call parent stem and not from runners, we prefer to do so as they are better. General impression seems to be that crop- grown from what we call second year's seed imported from foreign parts yield the heavier. By this I mean, seed shipped in from Wisconsin and planted first year doesn't yield so heavy a crop as seed planted from the potatoes thus grown. The second year's seed produces maximum return in crop as rule.

Farmers throughout potato region consistently select their own seed in very thorough and businesslike way. While potatoes grown under irrigation are more inclined to produce potatoes on runners, this tends also to result in an increase of production per acre. Where potatoes are raised under dryer conditions, without irrigation, the potatoes adhere more to the parent stem. That usually results in less production per acre.

3113 J. L. EWING.

Direct examination by Mr. Delph E. Carpenter:

James L. Ewing, Greeley, Colorado. Have resided at Greeley since 1875. Am not in active business at present time. Am partially retired, looking after lands more than anything else. Own farms. Prior to retirement from active work, was engaged in grain and milling business for about 25 years at Greeley, Colorado, at Model Mills and Elevator. For number of years was owner of the mill and elevator. In 1884 it was incorporated under name of Colorado Milling & Elevator Company. Was manager of properties from 1884 to 1904. Upon my retirement, was succeeded by C. F. Bell

who is now manager of same property. Was first engaged in the business as owner in 1880. We built the properties in that year.

In 1880 there were mills at Greeley called "Greeley Mills", or Johnson and Kennedy Mill. Mr. B. F. Johnson, now presi-
3114 dent of Union National Bank of Greeley, was then interested in mill. It continued to run after 1880 for about five years. There were two milling concerns in Greeley between 1880 and 1885. Old Johnson and Kennedy Mill discontinued after 1885. There were no other mills established at Greeley after that year. Subsequent to 1885 the Model Mill was only mill and elevator in Greeley. Old mill stood idle for number of years. It at that time belonged to what is now the Colorado Milling & Elevator Company. After some years it was destroyed by fire.

In 1880 there was more or less grain of all kinds grown throughout the Greeley district but not in large amount. Potato industry had not developed at that time. Grain industry grew in Poudre
3115 Valley subsequent to 1880 for few years. Reached maximum growth and developed in Greeley vicinity from 1885 to 1892. Remained constant from 1892 to about 1900. Other crops substituted grain subsequent to 1892 and caused growth of grain industry to remain stationary. Subsequently beet crop took a large acreage. Acreage of potatoes increased largely and acreage of grain decreased.

After potato and beet crops had developed their normal acreage, grain was principally used as nurse crop. It is generally true that grains are almost exclusively used for nurse crop for young alfalfa in the Greeley district now. We think alfalfa needs protection during first year and we grow grain partially for that reason. During first year's culture of land, crop of grain is obtained and also first year's growth of alfalfa.

3116 In early nineties used to purchase from 350,000 to 400,000 bushels of wheat at Greeley annually. Production of oats was probably 60,000 to 70,000 bushels per year, purchased at Greeley. Oats were partly consumed for feed on the place where raised and were mostly raised for that purpose. The same was true of barley.

Most of Greeley wheat tested more than standard weight of 60 pounds. Winter wheat tested 66 pounds. Spring wheat tested 64 to 65 pounds per bushel. It is safe to say that average Greeley wheat tested more than standard 60 pounds per bushel. Colorado oats run from about 45 pounds per bushel. That is true of oats raised in vicinity of Greeley. Standard weight of oats is 32 pounds per bushel. Difference between 32 and 45 pounds would be weight of oats in Greeley district over standard. Barley tests about its standard weight of 48 pounds per bushel. It exceeds that sometimes.

3117 Greeley Mill was exporter of flour during years I was in charge. We never shipped out any whole wheat but we shipped flour. In early years I purchased practically all wheat raised in vicinity of Greeley. Where wheat was purchased by outside parties it usually came in end to my mill for manufacture into flour.

Capacity of Model Mills at Greeley was 500 sacks per day equal to 250 barrels per day. During most of years during early nineties mill ran to its full capacity day and night the year around. Mill seldom stopped unless there was accident.

Annual output of flour from Greeley Mills ranged from 130,000 to 150,000 sacks of flour per year. We had our proportion of by-products, most of which was bran, most of which was consumed at home. Bran bore proportion of about 1/3 to flour. By-products of wheat manufacture were bran and shorts. In later years we were shipping bran away from Greeley.

More than 4/5 of total manufactured flour, during time I was manufacturing, was exported from Greeley. For number of years most of our product went into southern states. We shipped into most all southern states. Oklahoma and Texas largely. Think that is still principal market for Colorado flour.

Sack of flour, which is unit I have used, contains 98 pounds or one-half barrel. We did not always put it up in half barrels, but when we speak of it by sack we mean 98 pounds.

Greeley flour averaged about $2.25 per half barrel, per sack, throughout years I manufactured and shipped, or $4.50 per barrel wholesale. We did not retail. Correct figure of production can easily be obtained by multiplying production by price obtained.

3119 In 1880 there were no other mills in Poudre Valley except at Fort Collins. Mills at that town were well established at that time. The Hottel Mills owned by B. F. Hottel, the Farmers Mill and later the Hoffman Mill. The Hottel Mill was enjoying quite extensive milling business in 1880.

Believe there was more flour manufactured at Greeley in 1880 than at Fort Collins, but there was not much difference. Subsequent to 1880 mills were established at Windsor and Eaton. Eaton Mill was established in 1883 or 1884, and developed into large institution. It was about same capacity as Model Mills during early nineties.

3120 Production of flour I gave for Model Mills could be taken as fair illustration of production at Eaton Mills to best of my knowledge. Eaton Mill is still running. Windsor Mill was about 400 sack mill. It was engaged throughout year in production same as Model Mills during nineties. No other mills were constructed in Poudre Valley during years I was engaged in business. There were a number of elevators constructed for buying and selling grain, at Ault, Kersey, Farmers Spur, Timnath. Severance and some others. There is an independent elevator constructed at Fort Collins. There were other elevators constructed throughout valley which I do not now recall. Owners of these various elevators were engaged at grinding feed and grain locally at time I retired from business. Where owners were not engaged in manufacture of flour, they were frequently engaged in grinding of feed for local consumption.

3121 Other mills, of which I have spoken, exported flour and milling products in about same proportion I exported from Model Mills at Greeley. Most of grain stored in these various elevators throughout valley was manufactured at mills in the valley into

flour, bran and other products. Practically all of wheat produced in Poudre Valley was manufactured before export. About $200,000 was expended in buildings and machinery on mills at Greeley, Eaton and Windsor

Wheat production averages at least 40 bushels per acre, under good farming conditions in Poudre Valley. That has been average for last 15 or 20 years. It runs all way from 20 to 70 bushels per acre. We have had 70 bushels. Average would probably be 40 to 45 bushels per acre.

Oats produce on average 60 bushels per acre in Poudre Valley.

Barley produces on average about 60 bushels per acre.

During recent years some of elevators have shipped grain out of valley. Good many of them ship and manufacture right here. Part of it goes to Denver mills. That is true since same company owns all property.

J. L. EWING.

Cross-examination by Mr. N. E. Corthell:

3122 In the later years that I was connected with the flour mill when we did not have enough wheat grown locally, we shipped wheat in extensively from Idaho, Washington and Montana. Since, the acreage of wheat has been reduced, the larger part of that now grown is incidental to alfalfa, being used as a nurse crop. Wheat is grown upon unirrigated land in this district, principally winter wheat, but not to exceed over ten per cent of the total production, and winter wheat growing has come mostly since I quit business in 1904.

Cross-examination by Mr. John D. Clark:

The average price paid for wheat to the farmer has been about $1.25 a hundred, or from 60 to 75 cents a bushel. I have paid from 65 cents to $2.50 per hundred. The average yield per acre is about 40 bushels, so that the average gross return from the wheat crop would be between $25 and $30 an acre. I would not
3123 say that the cost of growing, threshing, and marketing the wheat would exceed ten dollars an acre. The acreage devoted to the production of grain grew constantly until about 1892, from which time the potato acreage increased until 1900, and since 1900 the increase in production has been in beets.

3124 Redirect examination by Mr. Fred Farrar:

Reason more acres has been devoted to beets and potatoes and less to grain is that potatoes and beets are more profitable, especially potatoes.

Highest and most economical husbandry requires rotation of crops. They rotate alfalfa as basic crop. Grain raised in this vicinity is more properly an incident to this system of rotation than a mere incident to alfalfa crop.

3125 Crop ro-ation in Poudre Valley is about as follows: Tract of land devoted to alfalfa for number of years will be plowed

up and devoted to potatoes. Then to some other crop and ultimately brought back to alfalfa again. Before it is put into alfalfa it is put into grain. It is possible to secure crop of grain and stand of alfalfa same year. They are seeded together and grain will mature early enough so that young alfalfa will not interfere with harvesting of grain. At same time alfalfa, which is perennial crop, is established.

Growing of winter wheat is of comparatively recent years. The system of rotation of crops mentioned, is practiced almost universally throughout the Poudre Valley. I refer to that portion which is irrigated. Result is that at some time or other during cycle of years covered by this rotation, all of land in Poudre Valley under irrigation is devoted to alfalfa. Alfalfa as a crop has a fertilizing tendency.

Alfalfa crop is equal each year to $15 worth of commercial fertilizer per acre. That is its fertilizing value alone, aside from its value for hay crop. This knowledge and resultant facts of
3126 plowing up alfalfa ground has come with more scientific farming in community. Alfalfa allowed to remain in ground as specific crop about three years in its rotation. Rotation is grain, potatoes or beets and then alfalfa and grain again. Yield of grain and all products has been about doubled since this method commenced.

My mill was first in this part of country to introduce roller system, which was at that time a new system and an improvement over the old mill stones.

Redirect examination by Mr. Delph E. Carpenter:

First became practice to break up alfalfa fields and plant other crops on alfalfa land in 1878 to 1880. Practice did not become extensive prior to 1890. Previous practice had been to plant a field to alfalfa and let it remain for 15 or 20 years.

3127 Am familiar with lands in vicinity of Greeley and new lands included within territory known as Greeley-Poudre Irrigation District. From my personal knowledge I would say that the lands of the Greeley-Poudre District are just as good as other lands north of Greeley. It is a continuation of same area.

Have observed various experiments conducted in country by settlers for raising grain by dry farming methods. It has been a failure, for reason that farmers do not obtain more than one or two crops out of five and discouragements are too great, spending life time without having adequate results. Dry farming is limited to small grains.

SILAS H. TURNER.

3128 Direct examination by Mr. Delph E. Carpenter:

Reside at Eaton, Colorado. Am Agricultural Superintendent of Great Western Sugar Company at Eaton factory. Have charge of agricultural department of that factory. My department includes handling of agricultural end of industry, receiving beets, distribut-

ing seed, looking after planting, thinning, etc., and in general way looking after entire agricultural part. It is my duty to see to production of crop and delivery to factory. I also have charge of delivery of by-products to various feeders. Engaged in sugar beet industry in Colorado 12 years. Started at Greeley factory; was interested in growing of beets at Provo, Utah, about 10 years before I came here.

3129 Engaged in cultivation of land by irrigation throughout my life time; 22 years in connection with the sugar beet industry. Grew beets for Lehi, Utah, factory first year it was established. It was first factory in west.

Territory under my control includes stations Eaton, La Salle, Clayton, Ault, Pierce, Cloverly, Alden, Gill, Barnesville, Lowe, Galeton and Myer. Galeton, Pierce, Myer and portion of Ault territory join Greeley-Poudre Irrigation District lands. Beet dump at Caleton is situated on lands within the Greeley-Poudre district. Lands in vicinity of Gill and Barnesville also join Greeley-Poudre District. District is north of these lands.

New railroad branch of Union Pacific constructed into Cloverly, Gill, Barnesville, Galeton, Alden and Myer districts is same branch of Union Pacific that was constructed to handle shipments of freight from Greeley-Poudre Irrigation District. Have understood

3130 that railroad was constructed with expectation of Greeley-Poudre District taking in that territory. Railroad was built in anticipation of traffic from Greeley-Poudre lands when brought under cultivation. Road has two branches, one northeasterly from Cloverly to Hungerford. Other branch goes up through Barnesville to Briggsdale.

Am more or less generally familiar with lands included within Greeley-Poudre District. Would say these lands are just as good as lands around Eaton and Ault from standpoint of sugar production. They are a continuation of the area.

3131 Sugar beet plant during first few weeks after it comes out of ground is very tender. Second year I was in Greeley we had to replant 2000 acres on account of frost. That was in 1903. Plants killed by frost were of April seeding.

Have visited Laramie Plains region, particularly in vicinity of Bosler, Wyoming. Made trip with Mr. Edgell, manager of sugar factory, and Mr. Timothy, Agricultural Superintendent of Greeley factory. Think it was during February, 1910 or 1911. Trip was made through solicitation of those people. They had been writing our general office for beet contracts. They wanted to go into beet raising business up there. Matter was referred to Mr. Edgell and myself as Eaton factory was nearest to that point, and asked Mr. Edgell if he and I would make this trip and go over territory and see what we thought of developing that country for sugar beet industry. They wanted to raise about 500 acres of beets.

3132 We decided we didn't care to take hold of it. We didn't want to go into it until it was tried on smaller scale. Principal reason was that seasons were too short; from information we obtained around Laramie, we understood they had frost there up as

late as fore part of June and as early as August. We decided that if such was case it would hardly justify them to undertake to grow beets there. We heard that frost occurred there later in spring than in Greeley district.

Such a country is not adapted to culture of sugar beets. It takes all of season we have down in Eaton district to mature a crop of beets. It costs just as much to plant, cultivate and irrigate a poor crop of beets as it does a good crop, such as grown in Eaton District. Cost of production of beets is practically same up to time of hauling them off, whether crop is 20 ton or 5 ton crop.

Cost of production per acre of sugar beets within my jurisdiction ranges from $40 to $45, including delivering product to factory or beet dump. We consider it requires about eight
3133 to ten ton crop to pay cost of production to farmer. That is returns from sugar beets alone.

We accommodated people in Bosler, Wyoming, vicinity in experiment of growing sugar beets. We sent them some seed to experiment with, sent them 300 or 400 pounds of seed. We agreed to take beets that they grew from that seed. We agreed to take them and pay them $4.50 per ton loaded on cars there, for the experiment. If they delivered any beets we expected to take cost of seed out as is our custom. It is our custom to advance beet seed to farmers and deduct price of seed from proceeds of first beets delivered in fall.

Beet seed sent to Bosler, Wyoming, would plant about 15 or 20 acres. We never heard anything from the seed or the beets. At that time my company was anxious to obtain all good outside acreage that was available.

Beet pulp and beet tops, also syrup are principal by-prod-
3134 uts of beet sugar manufacture. The beet tops are left entirely with farmer to consume or use as he sees fit. We dispose of pulp and syrup. It is fed entirely around our factories within radius of 3 or 4 miles. Some factories ship pulp but we do not on account of demand at factory. It is fed to sheep and cattle for fattening purposes. Large numbers of cattle and sheep are fed each season in vicinity of Eaton factory. We have one firm up there that is feeding 2000 head of cattle this winter right adjoining the factory. That is on premises formerly known as Bruce G. Eaton feed yards. Portion of it is in our yards.

25,000 to 30,000 head of sheep are being fed in neighborhood of Eaton factory from by-products this season.

Syrup is fed to animals by placing it on pulp. After they load pulp they distribute syrup onto load out of tanks with buckets. Other feeders grind their alfalfa hay and mix syrup with it. We do not feed any native hay. Beet pulp, alfalfa hay and syrup
3135 make up principal feeding ration of these animals. They are fed for purpose of fattening for market and not for mere growth. These animals are mostly exported to eastern markets. They there compete with corn fed animals from western and central states. This applies to both cattle and sheep.

Quality of animals fattened on by-products is equally as good as the corn fed. Feeding of these by-products tends to rapid fatten-

ing. This is especially so with old ewes. There is no feed that will take place of pulp and syrup with old ewes. Neither corn nor any other grain can compete with this ration for such animals, because feed is soft and they can chew it. Old ewes cannot eat corn. As a matter of fact, feeding of sugar factory by-products has led to greater utilization of animals of the country. Feeding of pulp, syrup
3136 and by-products has led to utilization of one of waste products of sheep industry. There is no question that old ewes that otherwise would perish from old age and exposure from inability to grind food with their teeth, are utilized as a source of meat production. Have never seen these foods applied to so great an extent with old cows, but presume it would work the same way.

Farmers and feeders with yards located on their private holdings in vicinity of Eaton utilize pulp and syrup for fattening animals. Limits of area where pulp is so utilized are about 3 or 4 miles around factory. It is limited to distance of economic haul. We are feeding about the same proportion of stock this year as usual.

3137 Sheep and cattle for fattening are brought from Wyoming. Many of them come from New Mexico. Cattle, most of them, come from Wyoming. About half of sheep fed in Eaton community are raised in Wyoming. Some of sheep fed at our factory come from grazing grounds in northern Weld County, Colorado.

Eaton factory produced more sugar beets per acre than any other factory in Colorado on an average. Our factory yields greater returns to farmers.

Direct examination by Mr. Fred Farrar:

3138 Beet pulp and by-products from manufacture of sugar are of sufficient value for feeding purpose that some factories ship it for considerable distances.

Most of $40 to $45 per acre cost of producing sugar beets is for hand and team labor. When I gave that figure as cost of production I meant cost to farmer of raising beets, including wages for himself and team for every day that he works with crop. Result is that acreage of beets is contributing very largely towards support of persons other than farmer who raises them. This labor is usually supplied by so called Russians, Mexicans and Japs. Each member of a Russian family, men, women and children, will care for about 5 to 7 acres during the season. The Japs will do a little better.

Each 7 acres of sugar beets, in addition to returns to farmer who raises them, directly or indirectly, and in addition to people who are supported by industry after beet leaves the farm, also sup-
3139 ports one person for every 7 or 8 acres planted. Taking industry as whole, it supports not only laborers who do hand work and farmer and those immediately connected with him, but also people who are directly or indirectly connected with manufacture of sugar at factory. Ultimate return is from sale of sugar and indirect returns from feeding by-products, that is, beet tops, beet pulp and syrup.

There is no other crop that grows in this general latitude which

will support directly or indirectly as many people as will the sugar beet.

Method of cultivation of sugar beets is as follows. Ground is plowed and prepared so that it is smooth. Deep plowing and breaking of clods is required. Ground is generally pulverized. Seed is sowed by drill. Seed is so small that drill plants practically continuous grow. After beets are up it becomes necessary to thin or block them, leaving one beet for every 10 or 12 inches. Later they are weeded by hand and during the summer require constant cultivation. When harvest comes they are loosened in ground by plow or puller and are pulled out of ground by hands and tops then are cut off. Beets are then loaded into wagons and from these wagons are loaded into cars by means of machines which are commonly called beet dumps but which are nothing more or less than chutes which dump whole wagon loads at one time by mechanical operation.

3140 Planting of sugar beets ordinarily begins April 1. If crop should be caught by late frost it is possible to re-plant and secure crop. We can plant up until May 20. Would not recommend planting as late as first of June. While young plant is very tender, we nevertheless have some latitude in date of planting. They may be replanted and made to return profitable crop.

Union Pacific Railroad constructed two branch lines into Greeley-Poudre Irrigation District territory in anticipation of development of territory. Several towns were started there in anticipation of development of district. Among them are Hungerford, Briggsdale and Camfield. Store buildings were erected; lumber yards and other commercial industries were started there in anticipation of the development. Capital was invested there upon faith of reclamation of district. These towns that were established will depend entirely for their development upon reclamation. If development is not accomplished the investment of capital thus made is practically lost.

3141 Direct examination by Mr. Charles F. Tew:

Have in my charge about 20 miles of territory extending along southern boundary of Greeley-Poudre Irrigation District. Territory is similar in character and soil as that included within the district. This is the territory to which I refer when I say beet yield per acre is larger than yield per acre upon any lands growing beets for factories in Colorado. We get largest yield in United States. For our territory as a whole, we get largest returns of any factory in Colorado. A part of that territory is contiguous to the Greeley-Poudre Irrigation District. We have grown largest crop of beets ever grown in United States for any one territory in Eaton factory district, also largest crop per acre. After lands of Greeley-Poudre Irrigation District have been brought into state of cultivation with these old lands, they will yield just as much.

CHARLES H. TURNER.

Cross-examination by Mr. Clark:

3142 In 1913 the sugar company had 16,500 acres of beets in the Eaton district, this being the largest acreage ever grown. In 1912 the acreage was 11,000 or 12,000. For 1914 we now have contracts for about 6,500 acres and expect to contract for 11,000 acres. Our contracts for 1914 are at a price of $4.75 per ton, with 12½ cents per ton extra for each additional one-half per cent of sugar above 15 per cent. The minimum price in 1913 was
3143 $5; the average price, $5.51. The decrease in acreage expected in 1914 is partly due to the decrease in price but mostly due to the return to potatoes.

3143 Redirect examination by Mr. Fred Farrar:

Difference in price I have described is difference of 25 cents per ton on beets of lower per cent in sugar, that is, it was a minimum of $5 in 1913 and in 1914 will be $4.75.

Redirect examination by Mr. Delph E. Carpenter:

We have one field of sugar beets near Eaton Factory that has been planted to that crop ten years, excepting one year. During that year planted beets but failed to get stand and then planted it to potatoes. That piece of ground has grown 12 crops with exception of this one year of 1911. It was very dry spring and I failed to
3144 get stand. We have averaged at least 18 tons of sugar beets per acre on that particular piece of land throughout the entire period. In 1912 we obtained 22 tons per acre.

Sugar content of beets raised in Eaton district in 1913 was little greater than that of any other factory. In other years Greeley factory had little better sugar content than we had. Sugar content of our beets is very good. Average sugar content of beets de-
3145 livered Eaton factory in 1912 was 16.45 per cent. In other words, 16.45 per cent of beet was sugar. In 1913, 15.42 per cent. Sugar content varies from year to year, due to climatic conditions.

3146 WALTER J. FARR.

Direct examination by Mr. Delph E. Carpenter:

Reside at Eaton, Weld County, Colorado. Resided there 25 years. Business live stock and farming. Am owner of irrigated lands in vicinity of Eaton. Have been interested in lands in that vicinity during last 25 years.

Engaged in sheep and cattle business, sheep business largely, during that term of years.

Engaged in live stock business for three years in Laramie Plains region, Wyoming. Was located on Laramie Plains about 25 miles south of Laramie City at base of Bull Mountain and Red Mountain.

It is 8 or 9 miles due south of Riverside Ranch. Place was located on small creek called Shell Creek, a tributary of Sand Creek which is tributary of Laramie River.

3147 Acquainted with Farr Ditch, a small ditch taking water from Shell Creek. I had it constructed when I was in that community.

Acquainted with Laramie River Valley since that time. During time was there became quite familiar with both the Big and Little Laramie River Valleys. Have been up in that country nearly every year since. Engaged in live stock business in Weld County, Colorado, in growing of animals as well as finishing them for market. During growing period live stock situated on ranch about 20 miles northeast of Greeley in Northern Weld County on Owl Creek. Kept them in that vicinity during years engaged in business. Have finished this live stock in vicinity of Eaton on irrigated area.

3148 Feed 2,500 to 15,000 head of sheep on average each year. Animals are fattened for market.

Was growing animals during years was engaged in live stock business on Laramie Plains. Animals there grown were finished for market in Nebraska. That was in years 1882, 1883 and 1884. Since that time I have been growing my animals exclusively in northern Colorado.

Have owned from one to six farms of 160 acres each under Eaton Ditch, the Larimer and Weld Canal and also the Larimer County Ditch of The Water Supply and Storage Company. The latter is same ditch that brings water across divide from Laramie River by means of Sky Line Ditch. Part of time during years men-

3149 tioned have been farmer engaged in application of water from Laramie River on Poudre Valley lands by means of Larimer County Ditch. Am familiar with agricultural development throughout that section of country.

Laramie Plains region is a stock country. It has been used for that ever since my acquaintance with country. There is some agriculture. It is not what I would term an agricultural country as compared with Poudre Valley. It is not agricultural country in sense that this is so termed. Laramie Plains is primarily a live stock country. It is a grazing country.

Am familiar with value of lands for grazing purposes on Laramie Plains. Value $1.50 to $2.00 per acre for grazing purposes. We found that it required 5 acres of land to give grazing for one sheep. For 1,000 sheep it would require 5,000 acres of land fenced up to give one season's grazing. Other stock would be kept off in

3150 order to give this return. It requires 12 to 15 acres of land to give summer grazing for one head of cattle.

Am familiar with land on Laramie Plains irrigated but not cut for hay and devoted to pasture of animals in winter time. That class of land irrigated for pasturage purposes is worth about $5 per acre. Price one would be warranted in paying for grazing privilege annually on that land would vary from 50 cents to $1 per acre, according to growth of grass, and thickness on ground and how well

it was sodded over, and I refer to land growing grass under irrigation but upon which growth is not sufficiently heavy for cutting of hay.

Area grazing lands in northern Colorado is quite extensive. This grazing land is worth, for runnig of stock, from $1 to $1.50 per acre. It requires a little more land to feed an animal in this region than it does on Laramie Plains. This is not as good a grass Coun-
3151 try. Think it would require from 1/4 to 1/3 more acreage to support same stock in northern Colorado. In comparing these acreages, I am comparing grazing lands in Weld County with grazing lands in vicinity of Shell Creek, Laramie Plains, Wyoming, which I believe is superior to grazing lands in northerly part of Laramie Plains. Grazing west and wouthwest from Laramie is better than to north.

Land at Eaton, Colorado, prior to construction of Larimer and Weld or Eaton Canal, averaged about same as grazing lands outside irrigated area do at present time. Values would be about $1 to $1.50 per acre.

I fix valuation of grazing land by first figuring cost of land, fencing and taxes and then figuring number of head it will support per acre.

Construction of Larimer and Weld Canal has increased land values. At the present time these lands range from $60 to $150 per acre, depending on character of land and location, the lay of the land and improvement and amount of water with the land. These values include water rights. Prior to construction of canal this was mere grazing land. Reason for increase was irrigation.

Methods of growing and finishing live stock in this region are as follows: Stock is bred and raised largely on outside range, on grazing land not used for agriculture, except that some of bottoms are used for cutting of hay, and stock is grown to one to three years old. It is then brought in onto farms during winter season, and is fed with alfalfa and grain and finished for market. It is then most of it shipped east. Some of livestock is finished on by-products of sugar factories. Sheep are principally fed. They are fed in small bunches of about 1000 head, located on different farms here and there over district. Greater percent of farmers feed some stock during winter. Some a few sheep, cattle or hogs, but most of them feed sheep or cattle. Sheep feeding is carried on more extensively than feeding of any other animal.

I have been engaged continuously since 1894 in finishing sheep for mark-
3153 et by feeding on farms, until last three years. Previous to 1894 I finished sheep off and on for several years.

Fattening sheep for market developed as industry in this vicinity along about 1888 to 1890, when it started in a small way. It has constantly increased from year to year since that time up until about four years ago when it dropped off on account of shortage of hay. Shortage was occasioned by grasshoppers and failure to get stand of alfalfa for two or three years. Feeding was restored and revived in 1913 and 1914. More feeding during 1914 than ever before in my district.

Fattening sheep for market is quite profitable to farmer one year with another.

75 cents to one dollar per head would be my average profit for feeding sheep over period of 15 years. That is in addition to profit received from fertilization on farm. Value of fertilizer received from stock fattening industry is very decided element of profit.

Fattening for market is carried on with small bunches almost altogether. There are a few large bunches fed but that has largely been by speculators or sugar factories. Larger feeders operat-
3154 ing on large scale usually locate at sugar factories if they can. That gives sale for sugar factory by-products. The fertilizer from even such feeding is left in the community.

Profits obtained under my experience would be fair example of profits obtained by large number of small feeders throughout Weld County. Farmer feeding 1000 head of sheep each year would not only receive profit of fertilizer but also a net profit of $750 to $1000. That would be an average. There are some years when they have made nothing and some years when they have made as high as $2 and $2.50 per head on sheep. I made a loss only one year during my experience and that loss was only 30 cents per head.

Fattening sheep for market is usual method of disposing of alfalfa hay raised in Cache la Poudre Valley.

Familiar with growing of alfalfa in Poudre Valley. Three cuttings are usually obtained each year. Some years we obtain a fourth cutting but you cannot depend on it. After third cutting alfalfa is watered and again cut or the growth is used for pasturage. This fourth growth is largely used for winter forage. It is
3155 especially valuable for conditioning animals for going on to winter feed. It is especially good pasture.

Lack of water for irrigation hinders production of normal tonnage of alfalfa in third cutting in some years. After second cutting is taken off there is not sufficient water then to irrigate the crop and third cutting does not amount to much unless there happen to be some rains, as there are in some years. If alfalfa is irrigated there is no trouble about getting three cuttings. It is common experience under Larimer County Ditch and Larimer and Weld Canals to have light or short third cuttings of alfalfa owing to water shortage. There has been a short crop during more years than there has been a good crop on account of shortage of water at that time.

Reservoir water is used on potatoes and beet crops first and then if they have enough left they irrigate the alfalfa.

First growth alfalfa matures sufficiently for first cutting in Eaton District on average about June 10.

First cutting alfalfa in Eaton and Ault districts, if properly watered, produces two tons hay per acre. When I speak of properly watering I refer to sufficient quantity of water to go over crop early in season. Some seasons are dry and we have absence of rain. During seasons when we have sufficient moisture to start with, we don't need to apply water until a little later, but if we are short of moisture and do not apply water early it cuts down the crop. During some seasons water supply comes a little late owing to lateness of melting of snow in mountains.

Two tons of alfalfa hay per acre is usually expected from first cutting.

Second cutting of alfalfa produces from 1 to 1½ tons per acre.

Third cutting of alfalfa produces about 1 ton per acre.

Total production per acre alfalfa hay in Eaton and Ault Districts is about 4½ tons per acre during year.

Fourth growth of alfalfa cannot be counted upon for cut-
3157 ting for hay. During most years we would not get enough tonnage to pay for cutting for reason that plant is too short. Last year was exceptional and there was some fourth cutting.

Am familiar with various rules adopted for measurement of alfalfa hay in stack to ascertain tonnage. Have bought and sold a great deal of hay by measurement. 512 cubic feet is standard adopted for ton of alfalfa hay in stack. This standard applies after hay has been settled in stack.

Shrinkage of alfalfa hay by settlement in stack depends great deal on how hay is put up. If hay was green when put up it will shrink from 20 to 25 percent. If hay is pretty well dried it will shrink from 10 to 15 percent.

3158 Rule of measurement I use is as follows: Ascertain length and breadth. Then take over measurements from ground to ground and subtract width from what we call over, divide that by two and that gives what we call height. Then I multiply height by width and length and divide by 512. That rule of measurement has checked very satisfactorily when hay was weighed over scales.

3159 It requires just as great an expenditure of money to raise and harvest an acre of poor alfalfa hay as it does an acre of good alfalfa hay, with exception of putting up hay. It does not cost as much per ton to raise good alfalfa hay with good stand and heavy yield as it does to raise poor alfalfa with lighter stand and yield. Lighter yields require greater cost per ton.

Am familiar with growing oats in Eaton District. Yield runs from 50 to 80 bushels per acre under the Larimer County and Larimer and Weld Canals. Exceptional crops of course go good deal higher. We frequently raise crops of over 100 bushels of oats per acre. Oats run about 40 pounds per bushel. They run more than standard of 32 pounds. If figures in bushels which I have given had been determined by standard of weight rather than by measurement yield would have been much larger. It would take more bushels if you take it by weight. The oats are very plump and heavy

3160 and weigh up well. If yield were ascertained by weight figures I have given would be increased about 25%.

Oats crop on my farms during years I have been farming have ranged in yield from 60 to 100 bushels and as high as 110 bushels of oats per acre by measurement. I have raised 100 bushels of barley per acre. Those are exceptional crops on very good manured land. Measurement I have given I machine measure.

Oats in Eaton District mature quite uniformly and early.

Never raised any grain on Laramie Plains but observed them growing there and they do not ripen up like ours do. Oats keep green on Laramie Plains. I have noticed different seasons when crop

did not ripen at all and frost would injure it. As rule oat crop does not ripen uniformly like it does in Eaton district. You will notice green streaks running through field. Oats mature later there than they do in Poudre Valley. Ripening is very slow on Laramie Plains.

3161 Am familiar with production of wheat in Eaton and Ault areas. Yields of wheat in that district range from 25 to 60 bushels per acre. About 35 bushels per acre, machine measure, would be fair average of that district. During last five years yield has not been as high as formerly for some reason. We raised from 40 to 60 bushels per acre of wheat.

Fluctuation in yields over different periods of years is common in all agricultural crops. There is variance from year to year. We believe that after raising sugar beets we do not raise as much grain per acre as we did prior to that time.

Am familiar with production of potatoes through Eaton and Ault District. Before 1911 crop would average from 75 to 150 sacks or 150 to 300 bushels per acre over the district. Very frequently yields would be far in excess of figures I have given. In 1911 potato crop was afflicted with a general blight. It took 95 percent

3162 of crop. In 1913 blight affected crop somewhat. Crop was about 80 percent. of normal in Eaton district in 1913.

Have lived or been interested in lands under Eaton or Larimer and Weld Canal for long periods of years. We have been short of water in fall seasons. Also in latter part of summers. We had to go up into hills and build a number of reservoirs to store water for later use.

Larimer and Weld Canal system has had nothing but litigation for 25 years past. Litigation has been over water all the time. I do not think there ever was a time when we were out of litigation. Constantly fighting for water supply. Country has developed notwithstanding constant strife for water supply. Area of land under Larimer and Weld Canal compares very favorably with other portions of United States with which I am familiar. It is very highly developed country agriculturally.

Development agriculturally under Larimer and Weld Canal has been great deal higher than development under Pioneer

3163 Canal on Laramie Plains. There is really no comparison as to development under two ditches in agricultural area. Crops under Pioneer Canal do not compare with crops under Larimer and Weld Canal. They have some good homes up on Plains above Laramie.

Climatic conditions make difference agriculturally between Laramie Plains region and Poudre Valley. I state this from my own experience.

Laramie Plains country is a high, cold country. From my own experience, it is even colder than other districts of same altitude. It is also quite a windy country with cold winds. Spring season is late. When I was living there we had a fall of one foot of snow June 12. That was depth on level. Weather gets cool very early

in the fall. That is reason oats do not ripen up as they should. They have cold nights and cold days too.

Poudre area is one of longer and warmer growing seasons. It is almost a month earlier in spring of year and about that much later in fall.

Laramie Plains region is considerably colder during middle of summer months than is Poudre region.

3164 We need all the growing season we have in Poudre Valley in order to mature crops. We could use a little more in fall of year.

Laramie Plains is live stock country for growing and maturing stock. They feed steers on hay for market there. They do not feed them for market to same extent that they do in Poudre Valley. I have never known of any sheep feed carried on on Laramie Plains as it is in Poudre Valley.

WALTER J. FARR.

Cross-examination by Mr. N. E. Corthell:

3164 I lived on Shell Creek on the Laramie Plains from 1882 to 1884. This creek was a tributary of Steamboat Lake, but when the lake filled up as it did the two years I was there, it would overflow into Sand Creek. Since 1884 I do not believe the
3165 lake has ever overflowed, as a ditch was taken out by Hutton, and since then the lake has become dry. Since I sold out, my trips through that country have been for pleasure and for the purpose of purchasing livestock. My statements relative to the value of various kinds of land are of the economical value and not market value, with which I am not familiar. The grazing lands on the Laramie Plains are worth more than those in Weld County, Colorado, because the grass is of better quality and more nutri-
3166 tious. Having stock upon land is necessary to its continued fertility, as the production of grains, potatoes and beets exhausts the soil. Alfalfa is a fertilizer, but does not furnish all of the requisites or elements supplied by manure. The production of beets is hard on the soil, as land after being cropped with beets will not produce good grain until it has been re-seeded back to alfalfa and fertilized with manure. The custom in this
3167 district is to plow up land which has been in alfalfa for two years or more, put in a crop of potatoes, and follow with a grain crop, which will be very successful. Either potatoes or grain will furnish good crops following alfalfa, but not following beets. I woud expect to see these results in any country, and to see larger crops upon land which has been in alfalfa than on land which has not been in alfalfa.

3168 Upon my ranch there was abundant water for spring irrigation of hay land, but not enough for the irrigation of cultivated crops. The uneven ripening of grain which I noted on the Laramie Plains I always attributed to the cold climate, but it might possibly have been due to uneven irrigation. A heavy frost on the night of August 25, 1910, injured the potato crop

materially in parts of the potato district, but where the frost did not strike there was a good yield. In 1911 the blight de-
3169 stroyed about 95 per cent of the crop, and about half the crop in 1912, and about 20 per cent in 1913. The acreage devoted to potatoes has been materially decreased, and it was estimated that in 1913 the acreage was about 60 per cent of what is called the normal acreage. There was a snow storm on June 12 in 1883 upon the Laramie Plains. I do not know its effect upon crops, as there were no crops in my vicinity. Some garden
3170 potatoes of a neighbor were frost-bitten. The snow disappeared quickly, and a very good growing season followed.

3170 Redirect examination by Mr. Delph E. Carpenter:

Natural growth of grass on Laramie Plains area is a little more nutritious than that in northern Weld County. That is the general rule in higher mountain regions both in Colorado and Wyoming. Same rule would apply to higher lands in Larimer County, Colorado. I used to run my sheep over Boulder Ridge on Sheep Creek in Larimer County, Colorado. I found same kind of grass there that they have on Laramie Plains.

3171 Actual value of land is finally determined by returns it will bring to the owner. Speculative value must finally return to the crop produced to owner on the land.

Wheat always did well in Weld County on land that had previously been planted to potatoes. We could always figure on a heavy A-1 crop of wheat on potato ground. When potatoes follow alfalfa, or follow potatoes, we have no trouble in raising good crop of wheat. Even before they took to plowing up alfalfa ground and planting potatoes then followed by wheat, it is fact that before that time they expected large yield of wheat from potato ground. When land was new we expected and obtained large yields right along. Potatoes do not have the same exhaustive effect on soil that beets do. You can plow up alfalfa ground that has been seeded for three years, followed with potatoes twice and get a large yield, but we have always figured alfalfa land of that character plowed up was good for from 4 to 5 large crops of potatoes or wheat before gain re-seeding to alfalfa. We could get two successive years of potatoes and then two or three years of grain before finally re-seeding to alfalfa. Alfalfa is re-seeded in conjunction with crop of grain as a rule.

3172 Frost of August 25, 1910 was the only frost at that time of year I have ever experienced in this region. Same general cold wave went through northern part of United States to Atlantic Coast and extended quite far south.

Frosts usually kill potato vines so that farmers can get into fields and harvest from the first to the fifteenth of October. That is in Eaton and Ault Districts and throughout Poudre Valley.

3172 TOBIAS MATTOX.

Direct examination by Mr. Delph E. Carpenter:

Reside 3½ miles from Greeley. Farmer. Have been farming in vicinity of Greeley about 30 years. Have lived on present farm 17 years.

Have 8 acres of orchard which I cultivate in conjunction with general farming. Have apples of different varieties, pears, cherries, plums, grapes, raspberries, currants, gooseberries and have raised some fine peaches but peach trees winter kill. There are 21 varieties of apples in this orchard.

Have Jonathan, Baldwin, Wallbridge, Gano, Greening, Winesap and other winter varieties of apples. Have summer apples such as Duchess, Transparent, Yellow Harvest and Red June. Have Concord and Moore's Early and other varieties of grapes.

Have raised Bartlett pears. Had very fine pears last summer.

First started growing fruit in 1883. Started an orchard on what is now called Colony Ranch. I set out orchard there when I first took up land from Government. It was bearing well when I traded ranch off and I then moved to where I now live. I set out this orchard and have raised fruit ever since.

I have a thrifty, living and growing orchard. I never had any blight.

I generally get about two, three or four first premiums wherever I show with my fruit. At last Apple Show in Denver I got sweepstakes. I got some first premiums on different varieties and I got sweep-stakes. Was in general competition including exhibitors from Oregon, Washington, Idaho, Utah, California, British Columbia, Montana, Michigan, Indiana, Kentucky, Arkansas, Missouri and New Mexico.

3175 Notwithstanding competition with those states I took sweepstakes with my exhibits. Apples are judged from standpoint of size and quality, also appearance, shape and color. Medium sized apples, well colored and of perfect form are preferred.

Raise some very large apples. Wolf River is largest variety. Had one that weighed one and one-half pounds. Wolf River is just a show apple. It is not first class cooking or eating apple but is principally for show. It is finely colored and large.

Practically all of my apples do well one year with another.

Grapes do very well as a rule and make good crop and are finely flavored.

3176 In 1913 I had 2,900 boxes of apples. I have sold apples from 60 cents to $2.50 per box. Average obtained would be about $1.75 per box. Box contains 48 pounds, 1 bushel. 1913 fruit crop from my orchard netted me $1500.00. Sold most of my apples at Greeley, but some of finest were shipped to Denver. I get more money for them in Denver than I do here.

7 acres of my orchard in apples. Balance of one acre is in small fruit, cherries, grapes, plums and other like fruits. I marketed the small fruit at Greeley.

I have 340 acres out of a total of 400 acres of my farm under

cultivation. Do not devote my whole time to orchard business. Simply carry on orchard in connection with general farming.

3177 Any person can raise their own fruits under irrigation where soil conditions are same as mine. I have sandy loam with clay sub-soil. If land in Greeley Poudre Irrigation district is of that character, there would be nothing to prevent orchards like mine throughout the entire region.

3178 J. F. McGREERY.

Direct examination by Mr. Delph E. Carpenter:

Have resided around Greeley 21 years. Was farming for 15 years, 4 miles northeast of Greeley in Pleasant Valley. That vicinity is on north side of Cache la Poudre River under Greeley No. 2 Canal. Farmed 80 acres.

80 acres is about average farm under Greeley No. 2 Canal. I sold out five years ago. Obtained $18,000 for my 80 acre farm including one canal water right and one reservoir water right.

During years was on farm became thoroughly familiar with agriculture as practiced in Cache la Poudre Valley. I attended to the farm myself. My family lived there with me.

3179 Have been in Commercial Club work during last five years. Entered that work owing to fact that I had made a study of grains and grasses for grerat many years and was acting as judge at great many fairs, both County and State, and at different fairs over the state. They put me at this work because I am familiar with grasses, grains, agriculture and irrigation.

Was put in office for purpose of obtaining more accurate statistics than had previously been obtained. Have given my time entirely to that work. Have traveled extensively in connection with agricultural statistical work. Don't suppose there is town of any size in Colorado which I have not visited. Have traveled in foreign states. Have made trips of three or four months' duration, going to New York, Pittsburg, Ohio, Pennsylvania and other states.

My farm in Pleasant Valley district compared favorably with neighboring farms. It was settled about same time, in early days.

Wheat following potatoes would run from 40 to 60 bushels per acre. For nine years I averaged 125 sacks of potatoes to acre. I have harvested as high as 175 to 200 sacks per acre. 125 sacks would be equivalent to 250 bushels.

Have cut 2 tons of alfalfa per acre on first cutting. Alfalfa ran from 4 to 6 tons per acre per year. Fourth growth alfalfa used for pasture. Once in a while fourth growth was cut in my vicinity, when we had plenty of reservoir water to irrigate it.

Failure to obtain cutting from fourth growth alfalfa came from lack of sufficient late water. We have to water alfalfa for every cutting. Some seasons we would not have quite enough water to give third crop good irrigation. Shortage of water would cut down yield.

Oats on my farm would average from 50 to 80 bushels per acre. Have harvested as high as 112 bushels per acre by machine meas-

ure. Standard for oats is 32 pounds per bushel. Our oats usually in Colorado run around 40 pounds per bushel. If we don't get 40 pounds oats we do not consider them good. To yield given you would add 25% in figuring production by standard measure.

3181 Barley will run from 50 to 80 bushels per acre. Have known one large yield grown on Igo place where California seed barley made 140 bushels per acre on 20 acres of land. This was by machine measure. It would run from one to two pounds over standard measure.

Production on my farm would be indicative of production in that vicinity. Production under Greeley No. 2 Canal may be just a trifle stronger than that under Eaton Canal. The water rights under Greeley No. 2 Canal are a little better and prior. Eaton Ditch in most years, compares very favorably with Greeley No. 2 Canal. Larimer County Canal compares just about the same.

Am familiar with land in Greeley-Poudre Irrigation District. These lands are just as good as the lands under the three ditches I have mentioned and lie about the same. Have had op-

3182 portunity to investigate soil in digging wells out there. Ran sheep in that region for two of three years. Soil is sand and clay mixed with clay sub-soil. Soil is designated as Colorado sandy loam in U. S. Geological Survey Map.

Land in Greeley-Poudre District will compare favorably with other adjacent lands under irrigation. It would be equally productive. During last few years extension of Greeley No. 2 Canal has been made and considerable new land has been reclaimed. This is of same soil generally and is just as productive as soil further down under Greeley No. 2 canal and raises just as large crops. Same is true of land recently brought under reclamation under extension of Eaton Canal. Taking these two extensions of old canals as an index, it is apparent it would just take few years to get the unreclaimed lands in that region in same productive condition. These arid lands are practically worthless now, unless you want to dry farm. That experiment has not proven a success. They are not good for grazing now owing to fact that they have been over stocked. Cattle and sheep have exhausted grass on them and growth is not prolific.

3183 This has been occasioned by situation near irrigated area. A great many farmers put stock on adjacent lands and bring the stock to their farms in fall, consequently ranges have been over stocked.

In 1911 I worked on system of getting accurate crop statistics in Weld County, realizing the fact that statistics we had before were matter of guess and were sometimes over-estimated and at other times under-estimated. In that year I prepared a set of blanks. Took copy to County Commissioners and they authorized printing of these blanks and County Assessor gave them to his deputies and each deputy was directed to take crop statistics of every man he went to in obtaining tax list throughout farming community. Assessors go out in summer. After crops are in ground and before harvest.

In 1912 was not satisfied with form of blank and so revised it and got out another in book form and Assessors did work also that year, turning in statistics compiled in 60 to 75 books under signatures of each deputy assessor. I compiled these in office giving summary of reports of all assessors covering county. We found
3184 these preliminary reports very satisfactory. Union Pacific Railroad officials came to office and obtained statistics and checked them and found them correct. They stated they also had system of checking. I concluded our method was accurate and have kept it up ever since.

This was made the law of Colorado in 1913. Henceforth assessors in every county are required by law to comply with this regulation. My 1911 blanks were not satisfactory. In them I did not state whether I wished data in bushels or hundredweight or tons and in many instances farmers got confused. Could not compile yields but acres compared with assessors' books. That is way we had of checking them up on previous years.

Industry of the valley is divided into a few general crops, for example, canning and truck gardening industry, potato industry, beet sugar industry, grain and milling industry and live stock feeding industry. My statistics cover the entire county. 255,169
3185 acres total irrigated land in year 1912 in Weld County. That portion of irrigated area in Weld County lying outside of Poudre Valley is about same as irrigated area in Poudre Valley and in Larimer County.

305,000 acres of irrigated land in Weld County in 1913, according to Assessor. Irrigated acres outside of Poudre Valley in Weld County about offset irrigated acreage in Poudre Valley in Larimer County. They are just about acre for acre.

Commodities canned or preserved in canning industry are cabbage, tomatoes, peas and beans. The Empson Canning Factory is located at Greeley. He has sub-factories at Johnstown, kind of a hulling station for peas and one at Ault, where they bring peas in and hull them and bring the hulled peas down to the Greeley factory and there can them. They transport them by automobile truck. The vines and hulls are put in sacks and fed to cattle or sheep. They are of about same feeding value as ensilage. That is the particular by-product obtained from peas.

3186 1,174 acres of canning peas were grown in Weld County in 1912. About 800 acres were grown in Poudre Valley for Empson factory. Average net return to farmer in dollars per acre in garden peas is about $35 to $40.

534 acres of green beans for canning in pod, string beans, were grown in Weld County in 1912. About 225 acres were grown for Empson factory at Greeley. Net return to farmer in dollars per acre from string beans is about the same as for peas.

1,726 acres of dry beans were raised in Weld County under irrigation during 1912. These usually bring about three cents per pound to farmers. They produce from 1200 to 1500 pounds per acre. Have known them to go as high as 1800 pounds but that is above average.

1,233 acres of cabbage were raised in Weld County in 1912. About 1000 acres cabbage were raised in Poudre Valley.

3187 1,041 acres of tomato-s raised in Weld County in 1912. Principally raised in southern part of county, there soil is more adapted to growing tomato-s than the soil adjacent to Greeley About 250 acres were raised in vicinity of Greeley.

36,408 acres of potatoes were raised in Weld County in 1911. In 1912 there were 20,952. Major portion of this acreage in Weld County with exception of a few hundred acres of early potatoes that were grown further south. Cache la Poudre Valley potato area is not devoted to cultivation of early potatoes. They are not as profitable as late potatoes. Falling off of about 16,000 acres was due to blight of 1911 and 1912. It started more or less in 1910. We had quite a frost in certain sections of our country and the blight was very bad in 1911 and 1912. There were three years of discouragement to farmers. I referred to same frost that occurred on Laramie Plains. I was there at Riverside Ranch at that time. Frost was heavy. We broke ice next morning to obtain water with which to wash. Ice was quarter inch thick. We went to Greeley in Automobiles. Hardest frost in this district was west and north of Greeley. Further north we went the harder was the frost. Across river on south side near Kersey, it was not very bad. Potato vines

3188 were just tipped. Further north we went the harder was the frost. I was at Riverside Ranch in Wyoming with party that was interested in Denver, Laramie and Northwestern Railroad. The party was trying to sell lands and I went as visitor.

205 acres of onions in 1912 in Weld County. In 1911 there were 264 acres. Low price in east caused dropping off of acreage in 1912.

2,300 acres of cabbage under irrigation in Weld County in 1911. In 1912 it was 1,233 acres. The low price obtained for crop caused falling off.

30,604 acres of beets were raised in 1911. In 1912 there were 55,000 acres. Beets have taken up the acreage that potatoes and other crops lost.

We have 550 barrel capacity flour mill at Greeley and one mill at Eaton and one at Windsor. There are elevators at other loading stations.

40,750 acres spring wheat in Weld County in 1911. 24,479 acres spring wheat in Weld County 1912. 38,324 acres winter wheat in 1911 and 14,498 acres in 1912. The 1911 figures for spring wheat included that on both dry and irrigated land. The 1912 figure for spring wheat was for irrigated land only. This applies also to winter wheat. 15,830 acres barley 1911. 17,510 acres barley 1912.

3189 88,899 acres of alfalfa in Weld County 1912. 87,881 acres of this were under irrigation.

136,500 sheep fed in Weld County during winter 1912-13. I procured those figures from railroad officials and that is actual number of head shipped out of district.

10,000 head cattle fed during winter 1912-13. Those figures are in round numbers and not absolutely correct.

Estimate by railroad men is 225,000 head of lambs being fed

in Poudre Valley during year 1913-14. There are about
3190 25,000 head of cattle on feed. The enormous yields of alfalfa and the by-products of sugar factory, beet tops, pulp and syrup have caused the increase.

Beets and alfalfa have in large part been substituted for potato crop during last three or four years, beets especially.

General figures I have given for Weld County, in so far as acreage is concerned, will apply to Poudre Valley. Larimer County is not a potato country. Potato figures I have given are confined almost exclusively to Poudre Valley; the Greeley District, as they sometimes call it. Larimer County feed as many if not more sheep than Weld County does. They have large hay crop and sugar factories with by-products. They also have a fine grazing section. In Larimer County portion of area, beets and alfalfa would be largely substituted for acreage given by me for potatoes in Weld County.

I do not have figures for 1913 as our Assessor has not obtained them.

3191 Average production of wheat in Weld County, all classes, both irrigated and dry lands, runs 32 bushels per acre. Average production of wheat on irrigated section will run from 40 to 60 bushels per acre. Fluctuations in figures which I have given generally indicate fluctuations that have occurred in production of crops in valley during my residence. It is expected to find fluctuations of one crop or another from year to year. This is usually occasioned by price of crop, if they have over production in immediate locality they all cease to raise the crop because they think there is not going to be any price next year. We usually expect to find rather low acreage in any one crop following a season of low prices for that crop. This applies to all crops. It includes the feeding of live stock. Price of hay has considerable to do with live stock feeding, also quality.

Alfalfa hay in Greeley, Eaton and Ault Districts, one year with another, will average about $7 to $8 per ton. It has brought as
high as $11 or $12 per ton. Alfalfa values depend on water
3192 supply for previous years and local conditions arising.

We have grasshoppers about once in six or seven years. Farmers fight them and their extermination depends good deal on climatic conditions. If springs are proper a great many grasshopper eggs are killed and the eggs rot in ground and we get rid of great many of them that way.

Cache la Poudre Valley is not more afflicted with grasshoppers, lice and other pests and diseases than other sections of the country. I have observed this condition of fluctuation of crops and products, as well as various causes that prevail in other sections of country.

Am unable to get accurate figures on production of minor truck garden products, such as lettuce, radishes, cucumbers, etc. It was estimated at about $25,000 worth annually of such produce sold around Greeley. Kuner people of Denver have salting sta-
3193 tion at Greeley for preserving cucumbers. Farmers raise good many cucumbers. Have never been able to get acreage accurately.

6,605 milk cows in Weld County in the irrigated sections in 1912. 7,810 in entire county.

125,653 hens in Weld County in 1912 of which 122,841 were in the irrigated section. 8,203 turkeys in irrigated section of Weld County in 1912.

5,818 hogs in irrigated section Weld County, 1912.

1,239 colts in irrigated section same year.

Horses raised in irrigated section Weld County are draft stock. Heavy draft stock, Percheron-Norman, Clydesdale and Belgians. Farm horses Greeley District average 1200 to 1300 pounds each. A good many of them go up to a ton. It is necessary to have large, powerful draft horses in Greeley District on account of number and tonnage of heavy loads of beets and potatoes and for the heavy
3194 farm work. The plowing of alfalfa sod is very heavy work requiring from 4 to 5 horses. Very large acreage of alfalfa sod is plowed up each year. I do not have the total acreage. Do have figures of new seeding each year but do not have figures of breaking.

26,966 acres were newly seeded to alfalfa in 1912.

The figures which I gave for production of colts referred mostly to draft stock colts. This class of colts at weaning time will bring $100 per head. The stallions from which these draft colts are obtained cost farmers from $2000 to $4000 per head.

J. F. McCRERY.

Cross-examination by Mr. N. E. Corthell:

3194 The total acreage of winter wheat in 1912 was 24,845, of which 10,347 was upon unirrigated land. I cannot give the production in bushels. The acreage of irrigated native hay land was 10,627; of unirrigated native hay land, 4,565.

3195 The acreage and yield of several crops grown under irrigation in 1912 as shown by one deputy assessor's report was as follows: 360 acres of winter wheat producing 10,770 bushels; 106 acres of spring wheat producing 2,720 bushels; 60 acres of oats producing 2,139 bushels; 25 acres of barley producing 825 bushels. All of this was in the Fort Lupton area in the South Platte Valley, and not in the Poudre Valley. A report cov-

3196 ering the district near Windsor in the Poudre Valley gives the acreage and yield of several crops grown under irrigation in 1912 as follows: winter wheat, 171 acres, producing 2,614 bushels; spring wheat 557 acres, producing 13,710 bushels; oats, 475 acres producing 14,099 bushels; barley, 482 acres producing 10,056 bushels. The report of the crops grown on irrigated land in 1912 in a district about 8 miles northeast of Greeley under the Greeley No. 2 Canal, gives the following: spring wheat, 394 acres, producing 4,975 bushels; oats, 442 acres producing 4,180 bushels; barley 499 acres, producing 11,045 bushels. These reports are sent in by the deputy assessors, and the information in them is obtained from individual farmers.

3197 Redirect examination by Mr. Delph E. Carpenter:

Have already stated my ability to get crop returns in bushels was very unsatisfactory. Some of farmers would give that in bushels and some in hundredweight and it was hard to get it accurately. I did not try to compile that. Series of figures Mr. Corthell referred to from books I happened to pick up included figures of this uncertain class. I find them to be very inaccurate. I checked back and forth on yields, enough to ascertain they were not correct. That was second year these books had been in existence but it was not compulsory to obtain these figures at that time.

80 acres about average farm under Greeley No. 2 Canal. There is at least one family on every 80 acres and during beet season there are sometimes two. Larimer and Weld area is not so closely subdivided. Larimer County Canal area is larger. Considerable portion of Larimer and Weld area is held by the B. H. Eaton Estate. Those areas are listed in units of about 160 acres as
3198 a rule. They are generally in a high state of cultivation.

Bruce G. Eaton is now acting manager of that estate and is largely interested in it.

I. Rothschild.

Direct examination by Mr. Delph E. Carpenter:

Reside Greeley, Colorado. Resided there 27 years. Wholesale produce business. Handle particularly potatoes, cabbage, onions and beans. All farm produce. Am principal member of corporation I. Rothschild Produce Company. Have been engaged in handling farm produce on wholesale basis in Greeley District 25 years. During those 25 years have been in intimate touch
3199 with production of crops throughout Greeley District, more particularly with potato industry.

Supply and demand gives Greeley potato its market. We have searched for markets because we have the potato and we usually get the best markets and get maximum price for potatoes raised here and our principal markets are Kansas, Oklahoma and Texas. Texas produces an early potato. Greeley potatoes follow their potatoes and supply the demand of that country. Their potatoes will not keep very long and by time we are ready to ship all of their potatoes are out of way. Same is true of Oklahoma but not so much of Kansas. Condition of market rather diminishes as one goes northerly.

Appearance is what sells potatoes. It is not so much the quality as it is the appearance. This obtains with potato no matter where grown. This means that potatoes must be smooth and good sized in order to outsell potato of dark color, rough and mixed. In other words, we have built up our trade here through efforts of grading our potatoes, by sorting them over screens that are made for that purpose and putting one variety of potatoes in a sack. We
3200 do not commingle sacks of two or more varieties.

Greeley potato has been of exceptionally good quality. This quality has built up a reputation for Greeley potatoes.

25 years ago when I entered the industry, the acreage of potatoes was limited. It has increased every year since then until 1911.

20,000 to 30,000 acres average between 1910 and 1911. Of years that industry increased, 1903 and 1904 showed most marked increase in production. Those were heaviest years.

11,000 car loads of potatoes was production of Greeley crop in 1903. Shipment was about same in 1904. There were something like 3,000 car loads left in the district that year. Total production of Greeley District for 1904 was about 14,000 car loads. Failure to ship the 3,000 car loads was owing to over production in United States.

3201 9,026 car loads was average production of potatoes in Greeley District as shown by number of cars shipped out in either year period beginning 1902.

Car load of potatoes contains 400 to 700 bushels. Most cars have limit of 30,000 pounds or 500 bushels. Average car would contain 550 bushels.

4,500,000 bushels would represent total shipments out of valley annual average during the eight years. This assumes an average of 500 bushels to car for purpose of easy computation.

72½ cents per hundredweight was average price paid to farmer over the twenty-one year period beginning in 1891. This price ranges from 20 cents to $1.75 per hundredweight during the time. Those are the low and the high figures.

Shipments of potatoes from Greeley District as rule begin in September and cease in May. We are shipping continually throughout the winter months. Heaviest months are October, November and January.

3202 Cuba is our furthest market to which we have shipped Greeley potatoes. I have been operator in that field. We have shipped to Cuba for 6 or 8 years. We also shipped to Mexico, City of Mexico, but not much beyond.

We have shipped car loads of potatoes as far east as New York City and as far west as San Francisco.

Greeley District is of particular importance for production and shipment of potatoes from standpoint of market for reason that they can get potatoes from Greeley District in less time than they can get them from most any other district. That is into our markets.

It takes a shipment of potatoes from 5 to 7 days to go from Greeley to the Texas market. It takes from 3 to 5 days for Kansas. Shipments from Greeley to Cuba or City of Mexico occupy about 12 days on average.

In order to meet these market conditions, we and our associate dealers in this district have constructed warehouses at most every railroad station in the district. The farmers have provided

3203 storage facilities on their farms. They call those storage cellars "dug-outs." They are cellars excavated down into ground for 2 or 4 feet then poles are erected and covered with straw and then with dirt, making storage warehouses. These dug-outs

on average farm in Greeley District would have average capacity of about 5,000 bushels. They are owned by the farmers. By this system of storage farmers are able to keep temperature uniform so as to preserve potato throughout storage season. Dug-out and warehouse facilities are sufficient to take care of nearly the entire crop throughout the district.

Have traveled extensively over the country during years I have been engaged in produce business. Have bought great many seed potatoes in different sections of country, principally in Maine, Michigan, Wisconsin, Minnesota, the Dakotas, Idaho and Utah. Have traveled extensively in potato producing districts of Colorado and Idaho particularly. I was the outside man for purchase of potatoes in those districts for two or three years. I represented several dealers who had associated themselves together for purpose of placing me in those fields to purchase these potatoes. During those purchases I had occasion to visit these various sections
3204 of the country. During that time I became familiar with potato industry as a whole throughout these regions. During time I have been engaged in business have kept a rather accurate record of conditions from year to year and prices obtained. It is a fact, that I am told that I have what is probably the most complete log or record of condition from time to time and year to year, to be found in the potato producing sections of the United States.

Figures of production and prices I have already given are taken from my memorandum which I have written up from time to time since 1891. I have that record written in the form of a log or sort of diary.

Pearls and Rurals are principal varieties of potatoes raised in Greeley District. They are white potatoes of late variety.

Experience of myself and associate dealers relative to ability to market early varieties of potatoes in competition with potatoes of later variety, for example, marketing Early Ohios and Early Rose potatoes dug and placed on market at same time as Mammoth Pearl and Rural New Yorker is that the early potato will sell all right when there are no other potatoes on the market, but as soon as the Pearl potato goes onto the market it is very hard to sell Ohios. The trade demands a white potato and they prefer the Pearl
3205 potato to the Ohio on account of its looks. The Pearl, while a late potato, is a variety earlier maturing than the Rurals. It ripens about two weeks earlier. The Pearl is the first variety marketed from the Greeley District out of the general crop of potatoes in that district, we have a few early potatoes every year. Early potatoes are usually marketed early. We find that necessary in order to obtain any market.

Am also engaged in handling and shipment of cabbage and onions. Production of cabbage and onions offers special advantage to potato industry by virtue of fact that it allows us to ship mixed cars. Trade in many of smaller towns prefer mixed cards of produce. It enables them to avoid shipping locally. This also affords

a means of commanding a little higher price for potatoes as well as for the cabbage and onions.

We dealers try to make from 5 to 10 cents margin per hundred on all potatoes handled by us from the Greeley District from 1890 up to date. Once in a while we get a loss. We think we handle potatoes on less margin in the Greeley District than in any other producing section of the United States.

3206 The Greeley farmer gets nearer the price the consumer pays for his potatoes than does the farmer from any other section. This gross profit which I have mentioned that the dealer obtains, includes all our office expenses, the handling of potatoes, loading and covering with straw and papering that we use in loading the car. I would not say that it included the warehousing. That is purely speculative, when we store potatoes that is on speculation. This warehousing has proved very disastrous during the last few years. Out of the gross profits of 5 to 10 cents per hundredweight, we pay all overhead charges incurred from the time the potato leaves the farmer's wagon until it is placed in consumer's place of business, excluding freight.

We dealers have had a representative in the southern fields for the greater part of the last ten years for purpose of assisting in disposing of our potatoes there. It was necessary to keep agent in those fields on account of rejections. Usually rejections are bona fide but keeping representative there avoided many rejections that we would have had had we not had man on ground. Rejections occur from causes sometimes originating here and sometimes in transit. Freezing is our greatest fear. That sometimes occurs in transit.

3207 Rejections occur from usual incidents of handling any crop of perishable produce.

Acreage in cabbage in Greeley District has increased to great extent during last 15 years. Acreage was rather limited 20 years ago. Later acreage became considerable of an item and 5 years ago it probably reached its highest point.

Annual production per acre of cabbage through Greeley District will run up to 25 tons per acre. We consider 15 tons of cabbage very good crop and I doubt whether average is over 12 tons per acre. These figures apply to both early and late varieties.

About 500 acres is average area devoted to raising of cabbage in Greeley District in later years. Price of cabbage fluctuates more than with most any crop. I have computed average price paid to farmer for cabbage over period from 1896 to 1912 and found that the average was 52 cents per hundredweight for the 16 year period.

3208 About 500 acres has been area devoted to onions in Greeley District during past few years. Average price obtained for onions according to records from 1896 to 1912 was $1 per hundred. Average production of onions in Greeley District is about 300 bushels per acre.

My firm alone shipped in 1913, 1,000,300 pounds of cabbage and 750,000 pounds or 25 car loads of onions.

Earliest shipment potatoes 1904 according to my books. First

car went out July 21. There had been a few shipments before that. These were early potatoes. They were raised in the Peckham District which is to the south of us and a little on the edge although we include it in our Greeley District. Since then that district has discontinued raising potatoes altogether. That is a region that usually produced early potatoes almost exclusively. They evidently found other crops more profitable.

330,000,000 pounds would represent annual average shipments of potatoes from Greeley since year 1903. That is equivalent of 11,000 car loads.

270,780,000 pounds per annum would be average shipment of potatoes from that district over a period of years figuring the average as 9,026 cars of 30,000 pounds each.

$2,055,616 would be the gross return to the farmers of the Greeley District as an annual average for potatoes, the average price of which was 72½ cents per hundredweight. That would represent with reasonable degree of correctness average amount paid Greeley farmers for potatoes covering eight years during which average shipments were about 9,026 car loads per annum. That gives fairly correct idea of potato industry of Greeley District at normal condition in its prime and under present conditions I think it will come back. Crop was affected with blight in 1911. It damaged crop so that we only shipped out 600 car loads. During the year previous we had shipped about 5,639 car loads. Our shipments were little heavier in 1912, the acreage had been reduced, we shipped out about 1,800 cars. In 1913 the potato industry shows recovery and there are great many fields of potatoes that average as well as in former years. 1913 showed about 60% of average crop. Considering
3210 the acreage planted the crop for 1913 was about 80% of normal. There is every indication of a return to normal conditions in immediate future.

Had occasion to make special observation and investigations concerning this blight which affected potato crop during 1911, and 1912 in particular. Was appointed by number of farmers to investigate conditions in fall of 1913. We finally ascribed blight of 1911 to climatic conditions. They have potato diseases in other producting sections of the world. This same disease has been known to afflict potatoes in other sections of the country. It has proven to be but temporary in its effect Blight of 1911 continued to afflict potatoes of 1912 for reason that seed potatoes from 1911 were planted in 1912. I understand that the same climatic condition affected potatoes in 1911 on eastern slope of Rocky Mountains from Canada to Gulf of Mexico,wherever they were grown,from strip about 400 miles wide. It affected potatoes of North Platte region of western Nebraska known as Scotts Bluff country and Mitchell country. The Stove Prairie country to west of us was affected as also Divide country to south of us and country all around Sydney, Nebraska. My statement that this was due to climatic conditions is on authority from men we have had here from Department of Agriculture who have studied the matter thoroughly. It is their opinion that with

proper change and care in seed, industry will return to its previous condition.

3212 Acreage 1913 was only about 25% of acreage 1911. 1911 acreage was 30,000 acres. That was about 10% to 20% above normal acreage. The acreage which was planted that year returned in crop about 80% of normal.

It is not uncommon to find potatoes throughout potato producing sections of United States afflicted with some disease. Idaho potatoes are afflicted with dry rot, powdery dry rot. It causes potatoes to decay and go to pieces. They have quarantined the Idaho potatoes. It has affected the market to some extent. Diseases have affected the potatoes in Maine. Reports give it as powdery scab. There is an embargo on Maine, on account of that disease. That section is quarantined now. We have never been bothered in Greeley District by that disease. Navada has the Eel worm. Wherever you go potatoes are liable to become afflicted with some disease, rot or blight, varieties more than sections.

I am informed that in 1881 or 1882 a similar disease affected the early growers. At that time acreage was very limited and there were only 3 cars of potatoes shipped from Greeley District that year. Thirty years previous to 1911 a similar blight affected the potatoes of this region.

L. ROTHCHILD.

Cross-examination by Mr. N. E. Corthell:

3213 The number of cars of potatoes produced and shipped from the Greeley district since 1903 has been as follows: 1903, 9,409 cars; 1904, 11,189 cars; 1905, 10,935 cars; 1906, 8,043 cars; 1907, 9,914 cars; 1908, 9,138 cars; 1909, 7,940 cars; 1910, 5,639 cars; 1911, 1,027 cars; 1912, 1,800 cars; 1913, 1,000 with
3214 645 carloads still on hand. The average for eight years has been 9,026 cars. The production reached its maximum in 1904, but the maximum acreage was in 1911, when more than 30,000 acres were planted in potatoes. In 1912, 18,000 acres and in 1913 from 6,000 to 7,500 acres were in this crop. In my opinion the potato blight that occurred in 1911 was due to climatic con-
3215 ditions, the extreme heat causing the stems of the plants to become woody and prevent the flow of sap.

3215 Redirect examination by Mr. Delph E. Carpenter:

I mean to state that there was some direct effect of heat upon plant at a critical stage of its development. This occurred during month of August. During that month we usually have cool nights and that is what gives growth to potatoes in this country. During 1911 we had very hot nights and hot days and that seemed to affect potato. In order to get good growth on potatoes it is necessary to have hot days followed by cool nights. This extreme heat in the nights of August, 1911, caused fuscarium in the vines, a woody growth. The sap refused to go to the tuber. It could not get down

through the stem and the consequence was it stopped its growth of the tuber and the potatoes were small and did not amount to anything. Prospect is, that if we can secure proper seed, acreage
3216 in Greeley District for 1914 will be twice acreage of 1913. There will be about 15,000 acres.

When acreage of potatoes fell off in 1912 and 1913, the acreage thus relieved from potatoes was devoted in large part to cultivation of beets. Increased acreage of potatoes of 1914 will most affect beet crop. That will be correspondingly reduced.

During this time of blight, the Greeley dealers purchased potatoes for our trade in outer districts. We had no other alternative. We sought other fields and handled potatoes from other producing sections. We continued in that because we did not have very large crop of potatoes here during last three years. As soon as normal conditions are restored at Greeley we will cut out other districts. It was necessary to make these purchases and shipments from other districts in order to hold our customers. If we had not
3217 done that we would have had to seek other lines of business. We would have got out of touch with our former line of customers. We wanted to be identified with shipment of potatoes.

Potatoes purchased from other parts were shipped and billed as potatoes coming from the districts from which they were shipped. For example, potatoes shipped from Idaho were billed as Idaho potatoes and not as Greeley potatoes.

Redirect examination by Mr. Fred Farrar:

It is my theory that this potato blight is transmitted to some extent through the seed. The pathological condition of potato was responsible for trouble. Climatic conditions started the trouble. Potatoes that have been planted from potatoes that were blighted may show the effect of the blight. That would show that there is a specific disease transmitted through the seed. Prevalence of that disease was accompanied by peculiar weather conditions.

3218 I answered that acreage of potatoes would be increased by low price of beets. By low price of beets I refer to the reduction of 25 cents per ton on lowest standard paid to farmers.

3219 It is a fact that this shifting from one crop to another is an example of the fact that farming can only be successfully carried on in communities where they can raise several paying crops. Where they cannot raise a beet crop they will raise a potato crop and if they cannot raise one of these, they will raise something else.

3220 FORT COLLINS, COLORADO, March 5, 1914.

W. A. DRAKE.

Direct examination by Mr. Delph E. Carpenter:

William A. Drake, Fort Collins, Colorado. Am farmer and sheep feeder. Engaged in that business in vicinity of Fort Collins for 32 years. Am engaged in banking business to some extent, looking particularly after farms and farming interests than those of bank.

Am associated with First National Bank. Was State Senator from my district for eight years.

I have always fed more or less stock on farm but have been
3221 quite extensively in sheep feeding business for 22 years.
First winter I fed about 1000 head. We gradually increased. For last 8 or 9 years we have averaged 40,000. I have on feed this year 42,000 head of sheep. I know of no other feeders in Poudre Valley who have so many. Have been engaged continuously during 22 years in feeding sheep for market. These sheep are fed for purpose of fattening animals for slaughter and for finishing the product.

Lambs and sheep fed by me and other feeders in Poudre Valley are purchased in Arizona, New Mexico, Colorado, Wyoming, Utah, Nevada and Montana. Lambs are generally fed on barley, corn and alfalfa. Old sheep are largely fed on alfalfa, sugar beets, sugar beet pulp and some cotton seed meal.

Sugar beet by-products are most valuable feed we have for old sheep. We fed about 15,000 head of old sheep. Some were fed corn and alfalfa and some were fed beet tops, some of them were fed sugar beet pulp and alfalfa and old sheep seem to have done better on sugar beet tops or pulp and alfalfa than they did on corn
3222 and alfalfa fed alone. Why they should do so well on sugar beet pulp I believe is one of the mysteries.

Poudre Valley is a finishing section for sheep. Other districts from which we purchase our sheep, particularly Wyoming and Montana, are largely growing districts. There are some sections in which they finish quite a number of sheep but they are largely a range proposition.

Laramie Plains region is very largely a growing region.

Farmers of Cache la Poudre Valley generally feed their sheep on their farms. It is our custom to divide up the sheep into smaller units. I feed more sheep than I can feed on my own farms so we feed large number on other farms where we can get corrals and hay. In such cases I simply take the place of the farmer feeding himself. I buy his alfalfa and rough feeds if he has any. I leave the fertilizer for his benefit. It is general custom throughout Cache la Poudre Valley for better class of farmers to feed some stock each winter.

3223 We generally obtain a little better price for our Colorado product than that obtained from sheep and lambs fed in other sections. As a rule we finish them better and have better quality of mutton than they do in other sections. This is true as well of sheep fattened on beet pulp and by-products as sheep fattened on hay, corn and barley. The sheep that are made fact on beet pulp will sell as well as those that are fattened on corn. I have made a number of shipments to eastern markets and Denver markets, with sheep fattened on beet pulp and by-products, and there has been no discrimination on part of buyers as to what they sheep were fattened on. They have all brought same money.

Lambs and sheep fattened in Cache la Poudre Valley are exported to Denver, Kansas City, St. Joe, Omaha and Chicago largely. Once in a while some shipments have been made south and east to

Buffalo, Jersey City and St. Louis. These lambs and sheep compete on eastern market with lambs and sheep fed over eastern and central states. The results are as I have given.

Barley fed to sheep in Cache la Poudre is grown in valley. I have never known of any barley to be shipped into the valley. It is all a home product.

Alfalfa fed is home product. Sugar beets and other by-products are home grown. Corn is only food that is imported. It is shipped largely from Nebraska. This year some of it has come as far
3224 east as Iowa. Cotton seed meal is imported from Texas and Oklahoma. Cotton seed meal is a good fattening product. It contains a large amount of protein which is necessary for fattening of animals and is used in connection with cheaper foods such as beet pulp and straw and molasses and makes an excellent feed. By using a certain portion of this food we obtain a perfect fattening ration for animals. We balance the ration by adding cotton seed meal. We do not use large quantities in balancing the ration. It is not used very much in connection with corn and alfalfa. With good alfalfa and corn we obtain a balanced ration and when feed is largely alfalfa, altogether alfalfa and corn, we do not care for cotton seed meal with it, but with straw and cheaper feeds such as molasses and pulp, it makes an excellent mixture.

Straw that is left from grain raised in Cache la Poudre Valley is largely cut and mixed with syrup to feed both sheep and cattle. Some of it is used for bedding for sheep. Very nearly all the straw of the valley is consumed in the feeding industry one way or another. We very seldom see straw stacks burned any more. In an early day it was not an uncommon sight to look out of evening and see twelve straw stacks burning all over country. You do not see that
3225 any more. Sheep feeding industry has utilized all that waste product.

Alfalfa contains large amount of protein which makes it particularly valuable as a food.

Four tons per acre per annum is about average production of alfalfa on farms of Poudre Valley. Owing to lack of water for irrigation we do not always get a good third cutting. Grasshoppers have also troubled us here for two or three years and our crops were damaged by them. They are a pest which comes and goes and are not permanent. Three crops of alfalfa are obtained in Poudre Valley. Sometimes we get quite a large fourth crop and it always makes a lot of pasture. Sometimes we cut the fourth growth but
3226 not often. Fourth growth is generally used by stock which are turned onto it and feed it off. We utilize nearly all of the fourth growth with old sheep and lambs brought in for feeding. It gives them a good start. It seems to put them in good condition for feed lots later. At any rates they take on flesh better when placed in lots if they have had a chance to forage in the field for a little time previous. This is also true of cattle.

Have grown 6 tons of alfalfa per acre. I purchase a great deal of alfalfa. I have known of some fields of alfalfa that would average

as high as 6 tons per acre but that would be about the largest yield I know of.

Have known 2½ and 2¾ tons of alfalfa obtained per acre from first cutting. I had 30 acres this year that measured 2¾ tons per acre for first cutting. There was some voluntary wheat with this alfalfa but I could not say that it was all alfalfa because examining hay I found out we had some wheat with it. My hay measured the tonnage I have given. Most of alfalfa I purchase is brought
3227 by measure. We use the following rule: Take one-fourth of the measurement over the stack, multiply it by the width and length and divide by 512. Another rule used sometimes is: Subtract width from over, divide by two and multiply by width and length. Third rule which is not very satisfactory, never has been to me, is to take circle of stock, that is add the width to the over, divide by four, square and multiply by length and divide by 512. In long years of experience I have found that average alfalfa in country does not hold out in weight on that rule. That is, if I were to buy a stack so measured it would not weigh out as many tons as the measurement showed, not unless they had stacked it partly green and it had settled a long time and was very compact. Average alaflfa put up in the country will not hold out by that rule.

512 cubic feet of alfalfa equals a ton. I have bought hay by that measurement all my life. We divide by 512 cubic feet to get tonnage.

I would say that the first two rules I mentioned would either one of them be correct for measuring alfalfa hay. The second rule that I mentioned gave absolutely number of cubic feet in stack. It does not make any difference, that rule is perfect as giving number of cubic feet in a board, whether measured lying down or standing up, so that would really be the correct rule for getting the number of cubic feet. That would weigh out as a rule.

3228 512 cubic feet of alfalfa hay would be required to make a ton in Wyoming, Montana or Nebraska. In state like Nebraska or any section of country where they have greater rainfall than we do, their stacks will settle more than our hay here. In case of that kind there might be a difference. If there was less rainfall than we have the reverse would be the case.

If stacks of alfalfa in a field were unsettled, that is, in condition they were soon after being put up in summer, and were measured on third rule I have given and tonnage ascertained by 512 cubic feet, average of hay in Colorado would not hold up.

Alfalfa is always allowed to settle in stack at least thirty days before making measurement and computation.

Have had occasion to test my measurements from year to year during past 22 years have been feeding, by later weighing the stacks already measured. In this way get double check. Have
3229 bought hay measured by this third rule. Bought two hundred tons at one time which was all weighed afterwards. It was very unsatisfactory and only weighed out two-thirds of a ton. It fell short one-third. That was worst experience I ever had. I don't buy by that rule only when compulsory. There are certain

sections of state in which that rule is almost completely used. In southern part of Colorado there is no other rule in measuringhay. At all such places we expect to get worst of it. That rule is also in vogue in Wyoming. I buy some hay in Wyoming. After buying first time I never buy any hay in Wyoming by that rule unless stacks are measured and we agree upon measurements.

In measuring hay it depends largely on way line is held so when I buy alfalfa in Wyoming, where it is custom to measure by that rule, we see before we close contract, we absolutely see hay measured and see that we get very liberal holding of lines on that hay so we know we are getting as near our money's worth as possible. Bought hay at Torrington, Wyoming, three years ago, 1200 tons of alfalfa. It was all measured by the third rule I have mentioned. I was not satisfied with that, so we drew lots on first, second and third cuttings by putting numbers in all stacks and putting them in hat and drawing them out, then we weighed one stack out of first, second and third cuttings of that kind of measurement and I paid for hay on basis of what it would weigh afterwards. We bought from 6 or 8 different men. Buying from about 6 or 8 different men and weighing hay, one stack, and averaging from each man that I bought of, we didn't find one solitary stack that held out to measurement. A purchaser buying by measurement with that rule gives benefit to land owner.

I use the following rule: One quarter of line over stack, multiplied by width and length. In measuring large numbers of stacks of hay on those two rules, where individual stacks vary greatly, it comes out in long run about same. The third rule falls short about one-seventh or one-eighth, something like that.

Have grown wheat, oats and barley principally in time have been farming in Cache la Poudre Valley. My experience in raising wheat shows that since we got to plowing up alfalfa and growing sugar beets we have made an average of almost 50 bushels of wheat per acre for last 15 years. My yields have gone as high as 68 bushels per acre. That is larger than average for the county. Yields approaching that are presumed to prevail among better farmers. We
3231 have great deal of 50 bushel wheat grown following sugar beets or on newly plowed alfalfa.

We grow some of our largest yields of wheat in Poudre Valley after sugar beets, in Larimer County. Last year I had one field following sugar beets that made 60 bushels of wheat per acre.

Have grown oats ranging from 30 to 100 bushels per acre by machine measure. These oats are usually heavier than standard weight so it would add 10% to 15% at least. Oats weigh from 40 to 44 pounds to bushel as rule. Think it would be safe to add 8 pounds as a rule every year. 8 pounds would make 25% of 32 pounds thus requiring addition of 25% to machine measure in order to get bushels per acre. You may get many 70 to 80
3232 bushel yields per acre by machine measure. Those yields may be expected by farmers under good conditions.

Have raised about 80 bushels of barley per acre.

Larimer County is not much of potato section.

Sugar beets and fruit are principal crops in Fort Collins district of Poudre Valley outside of alfalfa and grain. A large acreage is devoted to culture of sugar beets. We have factory here.

3233 Have list of about number of sheep that have been fed in entire section of the country. It would include sheep that were fed at Loveland and Longmont which would make pretty close estimate of what have been fed in Poudre Valley. From my experience and knowledge of sheep feeding industry think I could apportion that pretty accurately. We know number of cars and about how many sheep are usually shipped in a car and have ascertained in that way about number that has been fed and can approximate very closely for the Poudre Valley.

This list I have I made from car records and make an estimate. 1903, 207,000 sheep; 1904, 344,000; 1905, 509,000; 1906, 582,000; 1907, 562,000; 1908, 645,000; 1909, 462,000; 1910, 291,000; 1911, 160,000; 1912, 232,000; 1913, 500,000; and this spring approximate number of sheep on feed in same district is very close to 700,000 head.

To get correct number fed in Poudre Valley we should take from 75% to 80% of the numbers given. They do not feed many sheep at Longmont or at Loveland.

Am not so well posted on cattle industry but I have been told by cattle men and others that there are around 25,000 head of cattle on feed. More this year than previous years.

3234 The cattle feeding industry seems to be increasing very rapidly. They have always finished good many cattle here since we got alfalfa hay, but since day of sugar beets and getting pulp and tops, cattle fattening has largely increased. These cattle are largely fed in transit.

By feeding in transit is meant that railroads make rates to all points on Missouri River and then charge certain amount for privilege of stopping off and finishing the feeding. The universal rate is now $15.40 per ton. There is a through billing with privilege of feeding in transit of most of sheep fed in valley.

Sheep are produced in northern Larimer and Weld Counties. They are very largely fattened in Greeley and Fort Collins Districts. Same is true of cattle.

One man can take care of about 1500 sheep if you have quite a flock. In small lots it takes more men for that number.

One ton of alfalfa hay will feed 6 or 7 sheep. With sheep amount of hay varies with amount of grain. If cattle are fed other feeds they eat less alfalfa. I fed bunch of cattle and a bunch of sheep one winter and sheep had grain and cattle did not and it took same amount of alfalfa to feed one steer that it did for twenty lambs, but lambs had some corn with it and cattle did not.

In speaking of alfalfa production on farms for this year I referred to year 1913.

W. A. DRAKE.

Cross-examination by Mr. N. E. Corthell:

3236 The first plowing up of alfalfa land and planting the same in wheat occurred about 20 years ago, and the practice has increased the yield of wheat very greatly, about two and one-half times in my own case. Field peas, a very successful crop, largely used in feeding sheep, are not raised to any extent in the Poudre Valley.

3237 Redirect examination by Mr. Delph E. Carpenter:

Average profit per head obtained by farmers from feeding of sheep in Cache la Poudre Valley over a period of years, exclusive of fertilizer obtained, would be from 60 to 80 cents per head. Fertilizer obtained from stock feeding is considerable source of profit especially when you are growing root crops afterwards, like sugar beets or potatoes.

In earlier years of wheat growing in Fort Collins District, when sod was first broken up and land was new, we grew from 30 to 40 bushels of wheat per acre and by continually cropping with wheat we got wild oats into the country and our wheat yields were reduced by foul lands and steady cropping. The falling off of the production of wheat was due to failure to rotate and the diminishing fertility of soil. Production was about as I stated at the time of this change in manner of rotating crops by plowing up alfalfa sod and putting it into wheat.

HENRI S. MCCLELLAND.

3238 Direct examination by Mr. Fred Farrar:

Have lived at Fort Collins for forty years last June. Father was pioneer newspaper man of Fort Collins. He established Larimer County Express in fall of 1872 or spring of 1873. That paper is still published here. It is a daily. There are three papers published in Fort Collins; all three are dailies and publish weekly editions.

Am engaged in fruit business and general farming. Orchard located about 4½ miles south of Fort Collins. Irrigate mostly from Pleasant Valley and Lake Canal. That ditch takes water out
3239 of Cache la Poudre River on south side about ten miles west of Fort Collins.

Have about 80 acres of orchard. My orchard is commercial and not incident to my farming business. Orchard devoted to apples, cherries and plums. Have about 50 acres apples; about 25 acres cherries and rest of orchard is in plums. Raise nearly every variety of apples but principally Jonathans, Ben Davis and summer varieties, such as Wealthies. Raise Montmorencies and Morello cherries, and many varities of plums. They are what are called cultivated native plums. By native, I refer to native of the United States. Plums vary in size from quite small to medium size. They are sour plums.

Orchard established 1875, planted just a little at a time as my

father could afford to buy a few trees every year. I am still adding to it. Irrigation is necessary for this crop.

3240 Ben Davis apples on old established orchard in full bearing yield close to 1000 bushels per acre. Some varieties of apples begin to bear within three years after they are set out but we do not consider them in full bearing until about eight years of age. Trees continue to grow and increase in size and yield every year. Apple trees in this vicinity are not so large as they are in eastern states. 1000 bushels of Ben Davis apples per year per acre is reasonably good crop. This would apply to such trees as I have on my place. Trees from eight years old and over.

Jonathans bear about 500 bushels per acre per year. Wealthies bear about same as Ben Davis, 1000 bushels per acre per year. Trees will average from fifty to seventy-five per acre.

Cherries with normal crop will run close to 15,000 pounds per acre on good large trees. Morello cheries commence to bear next year after they are planted. Montmorencies bear about three years after they are planted. My experience is same as to progress of yield as trees grow older. Cherries run from 150 to 200 trees per acre. Yield of good normal crop of 15,000 pounds per acre per annum is from well established orchard of large trees from eight to ten years of age, such as I have in my orchard. My cherries are marketed by the pound and that is the unit measurement employed.

Plums are very heavy bearers and I would have to guess a little as to production. I would say that they would yield from 6,000 to 7,000 pounds per acre per year.

Fruit is quite extensively grown in this area, especially on river west of Fort Collins. La Porte is situated in the heart of that fruit section. I am not in that section. Mr. Mogg has a large orchard north of Fort Collins. Mr. C. R. Evans has an orchard west of Fort Collins; he has 40 acres of cherries.

3242 All kinds of small fruits are also raised around La Porte. Apples, plums, currants, strawberries, raspberries and blackberries are all raised there. The area which I have described as generally to west of Fort Collins, mine to the south and those to the north are all in the Cache la Poudre Valley. The conditions—yields are about the same in all of these localities.

A very small portion of the fruit is consumed locally.

I market quite a considerable portion of my fruit in Wyoming. One year I sold my whole crop of apples to a Laramie City firm. The name of firm was Wyoming Commission Company. Mr. A. L. Erb was representative with whom I dealt. I shipped him between 12 and 15 car loads of fruit. One car went to Hanna, Wyoming; another to Rawlins and all rest were billed to Laramie City.

Denver consumes quite a large portion of the summer apples. Winter apples are shipped to Cheyenne, Wyoming, Oklahoma, Texas and Chicago.

Am able to compete with apples from western slope of this state and also from fruit growing districts of United States.

3243 Cherries are marketed mostly in Chicago. In previous years marketed them in Kansas. Used to ship my own cher-

ries mostly to Kansas points, quite a few to Kansas City and St. Joe, Missouri. Cherries are packed and handled in bulk. They are pulled from stems and put in small boxes and loaded in car. From there they are taken to Fort Collins where they are packed by firm who buys them. There is cold storage concern in Fort Collins prepared to handle them.

Plums are marketed mostly in Denver.

About 50 cents per bushel is average price obtained for Ben Davis apples. This is the price boxed. One box of apples is a bushel.

Average price obtained for Jonathans is $1.25 per bushel or box.

Average price for Wealthies is about 75 or 80 cents per bushel or box. Other varieties of apples would bring about same price as Wealthies.

Five cents per pound is obtained for cherries. With 15,000 pounds yield per acre, my return would be about $750 per acre. This is
the price obtained for cherries in bulk and not boxed or
3244 crated. Expense is merely taking them from trees and de-
livering them to railroad station immediately adjoining orchard. Colorado and Southern runs right along immediate boundary and through orchard.

Plums bring from 2 to 5 cents per pound, varying with condition of season. I would say that they would average about 3 cents per pound. They are sold in baskets. The price I have given is net after we have furnished the baskets.

Crop varies from year to year both as to quantity and quality. Occasionally have frosts; these occur when trees are in blossom. Trees bloom from May 1 to May 15, as nearly as I can remember. Of course have other physical conditions which sometimes con-
tribute to loss which might be incident to any country. We
3245 have occasional hail and winds damage the fruit a little.

Took $18,000 from my orchard during one year. It was a good crop and with good prices, normal prices I should say, it was probably a little above average crop. Would say that that amount of return should average right around the normal annual crop with normal price.

Fruit raising is my principal business. Nearly all of the farmers in my vicinity have orchards incident to their farms. Some of these are commercial orchards. With same care given to cultivation their returns would be about same as mine. My land and conditions are not extraordinary in any extent. I specialize in raising fruit.

3246 Redirect examination by Mr. Fred Farrar:

The area of 12 miles takes it practically to foothills of mountains. Just within first range of hogbacks or foothills is what is known as Pleasant Valley. This is within the outer range of hogbacks or foothills but outside of the mountains themselves. It is just this side of the mouth of the cañon of the Poudre River. Fruit raising is quite large industry in this section. It is by no means confined to my orchard or to the other two orchards I have specifically named.

3247 C. E. MOGG.

Direct examination by Mr. Fred Farrar:

Am raising fruit and taking a rest. Previously was clergyman in Pennsylvania. Have nominal charge called Fort Collins Circle at this time. It is indefinite and I work as I choose. Live in Fort Collins.

Have orchard 3 miles northeast of Fort Collins. Between 25 and 30 acres in orchard. Orchard 10 or 12 years old, part of it 4 years. Devoted to cherries, apples, plums and prunes. Have about 20 acres cherries, 2 acres apples and balance in plums and prunes. Have about 200 trees. Major portion of orchard devoted to cherries.

Last year yield was quite prolific. Yields have been quite uniform but I never figured it very close until last year. My 10
3248 year old trees produced about $400 per acre.

Crate some of my cherries but sell mostly in bulk. When crated standard box is 24 boxes to crate. Received about $2 per crate on average. Cherries that are not crated are sold in bulk. Receive 5 cents per pound for such.

$2800 was received by me from 7 acres of young Morello cherry trees in 1913. This was gross receipt. Cost of harvesting was about $300. Received not return of $2500 from 7 acres of young Morello cherries, just accounting for harvest, of course there was previous expense of cultivation. Am able to segregate that particular 7 acres from balance of orchard because they were set out at the time by themselves in a separate year. Those 7 acres are in no manner different from the rest, they adjoined the others. They are merely a sample of the return for the balance of the orchard last year. They are younger than the other trees in the orchard. I don't think there would be much difference in the yields. That would be
3249 a fair standard of return from my whole cherry orchard.

Am acquainted with Charles R. Evans. Know his cherry orchard west of Fort Collins. Think he has 35 or 40 acres. The fact that Mr. Evans sold $3000 in fruit off his orchard 3 or 4 years ago, started me into the orchard business. Orchards in vicinity of Fort Collins are not confined to mine, Mr. McClelland's or Mr. Evan's. There are many others. All I know to northwest are Mr. Jones and Mr. Anderson. There are good many orchards about La Porte but I could not approximate acreage. Fruit is not confined to any particular spot but is general throughout this part of valley.

My experience with apples has been quite favorable with good yields. Of course my trees are young and small. Ben Davis apples this year, 1913, brought about 700 bushels per acre, 700 boxes of one bushel each. These were marketed locally and to towns of within 25 miles of here or at Denver.

My prunes bring from $1 to $1.25 per crate. Four small baskets make a crate, about 22 pounds I think. They are marketed in same territory as apples. They are not treated in same manner as big commercial crops from California are, but sold fresh for family use.

Met young man by the name of Gardner, a photographer from

Greeley. He took picture of my orchard. Took several photographs. He explained to me they were for purpose of this case.

Made Fort Collins my home about one year. Resided at Greeley previous to coming here. Formerly had a charge at Wilkes-Barre, Pennsylvania.

I set out this orchard. It was a vacation joke. I came out here for fun and didn't expect it to be so serious a business proposition. In other words I commenced a vacation amusement and it became a profitable business. It has run ahead of my expectations.

3251 I am under Larimer County Canal of The Water Supply and Storage Company.

Market value of orchard lands in vicinity of Fort Collins runs from $300 to $1200 per acre for good, well developed cherry orchard. Apple orchards would not be worth quite so much.

3252 FRANK BAXTER.

Direct examination by Mr. Fred Farrar:

Live at La Porte, Larimer County, Colorado. La Porte is 6 miles northwesterly from Fort Collins on Cache la Poudre River. It is about 3 miles in direct line from canon of Cache la Poudre River where it emerges from mountains. Have lived in Larimer County 30 years last September.

First few years was in cattle business in hills west of Fort Collins but most of time since then have been in general mercantile line at La Porte, part of time in Fort Collins.

La Porte is an unincorporated village. We hardly know what our village is. I should say 50 to 60 people right there in a little cluster. It is situate right on river. The immediate irrigated area of Cache la Poudre Valley next to La Porte is rather narrow not averaging over a mile at that point or a little above. Perhaps 1½ miles across. Some of the land is broken and is of no value. Bellvue in

3253 Pleasant Valley, another village, is just about two miles west of La Porte. Front range of hills before you enter mountains is called hogbacks. It is of stratified formation consisting of sand stone strata. This Pleasant Valley I mention is just inside the first row of hogbacks between what we call hogbacks and the foothills. It is what might be described as a pocket in there.

Cache la Poudre Valley, as far as plains part is concerned, really commences at point where river comes through those hogbacks and that is just above La Porte. From that valley spreads out in fan-like shape being wider as you go downstream.

From Fort Collins up the river part of way there are general crops such as alfalfa, grain, sugar beets and like crops. This is for first 2 or 3 miles. As you get nearer La Porte it is principally gardening and fruit. Over in the Pleasant Valley there is a good deal of market gardening but rather more farming than there is in immediate vicinity of La Porte. When I say farming, I am making a distinc-

3254 tion between farming and market gardening. When I mention gardening I refer to market gardening.

A spur of the Colorado and Southern Railroad runs from Fort

Collins to La Porte, Bellvue and beyond. That is only a freight line with no passenger service. It is freight only for car-load lots. There are no other shipping points on this line other than La Porte and Bellvue in that area. There are sugar beet dumps between Fort Collins and Bellvue. There is a dump at La Porte and also one at Bellvue.

La Porte District includes perhaps four square miles. I think that would cover practically the gardening area where gardening is done in the La Porte District, of course, that is not all gardening, but that would cover all of the territory where market gardening is done. Am not trying to draw distinction between La Porte District and other district between Fort Collins and La Porte and what may be just above La Porte. I am defining the La Porte District as merely containing area of four miles and by that I refer to what actually comes to La Porte to be shipped.

Onions, cabbage, strawberries, raspberries (both black and red) apples, plums and other crops are raised in La Porte District.
3255 There are some cherries and more or less celery but not on so large a scale as the others. Cabbage is shipped in car lots. Probably 20 cars per year. Cabbage yields about 20 tons per acre. Prices for cabbage vary a good deal. I have known it to be quite low but I think they figure on about $1 per hundred. A field yielding 20 tons per acre and sold at $1 per hundred would bring $400 per acre to the farmer.

Cabbage raised by Mr. Herring, one of our largest producers, is usually shipped by rail to Laramie City, Wyoming. Don't know whether he ships to Cheyenne or not. Most that I know of is shipped to Laramie. Great deal is hauled by wagon to Laramie, Cheyenne and North Park.

10 to 15 car loads per annum of onions are raised and shipped from La Porte. Yield is from 300 to 400 sacks per acre.
3256 They complain if they receive less than $1 per hundred and obtain sometimes $1.25 per hundred. Onions yield from $300 to $400 per acre.

Onion seed is another industry that is centered at La Porte. A great deal of seed is raised. Cannot give amount or price but a large amount is raised every year for export. Denver firms handle most of that. Practically all of it goes out of the valley.

Have forgotten number of car loads of fruit that went out this year. I know one man shipped 56 cars and there were two or three other shippers. One gentleman from Laramie Grocery Company bought several cars there and sent his people down to pack apples and to ship them out but cannot tell how many.

Practically all kinds and varieties of apples are raised. About $1 per box or bushel is usual price received at time of shipping. Have about 85 trees on one acre of land on my place. Have had each tree yield from 7 or 8 bushels to as high as 22 or 23
3257 bushels. This is yield for same year on different trees and different varieties. Think trees would average ten bushels each for good apples.

Inclined to think majority of orchards in that community are better than mine.

$680 would be return from my orchard figuring 85 trees in my orchard occupying approximately one acre of land with average yield of only eight boxes of apples per tree and bringing $1 per box.

In addition to this return from apples, I have two rows of raspberries between each two rows of trees and I cannot give you exact figure produced from these berries, but we sold last year, which was first year after bearing, about $150 worth of raspberries off of that patch besides what we put up and gave away and used. That acre brought me at least $820 last year.

Nearly all of the orchardists or farmers in that locality have plants such as raspberries or other small berries between the apple tree rows in their orchards. Mr. Younger told me the raspberries inside of his trees paid him over $400 per acre in addition to the production of apples last year.

3258 Strawberries are very good crop there. From $300 to $400 per acre is realized from strawberries.

This is all raised under irrigation. It would be impossible without irrigation.

Great deal of the fruit and produce from La Porte District is hauled by wagon to Laramie and Cheyenne, Wyoming. Men make that their business during the whole year, buying and hauling to those places. Quite a little goes into North Park.

La Porte District is nearest to Laramie Plains region of all the lands in the Poudre Valley. It is about 65 miles' haul from La Porte to Laramie. There are from 4 to 5 men who are engaged regularly in hauling fruit and vegetables from this district into Wyoming.

Do not know whether it is more expensive to ship by rail than by wagon freight. I do know that the men who do the hauling say they make good wages by hauling it themselves.

This has been the practice ever since I have known that country. Think there was more shipped by rail last year than ever before. It is necessary to ship on C. & S. and transfer to Union Pacific Railroad in order to get to Laramie by rail. Until Colorado & Southern extended to Cheyenne few years ago, it was necessary to do this to get to Cheyenne by rail.

Average farm unit in La Porte district is about 5 acres. Owner of land will lease to several parties who will farm from three

3260 to five or six acres each.

5 or 6 acres of land in La Porte District will support a family. I am speaking of the garden land.

I counted 116 people supported on one square mile at La Porte. Portions of the district would not run so high. Think I could find another square mile that would run fully as high and maybe a little higher. I refer to square mile starting south of river and running north a mile and taking half mile on each side of this line. Think this area would run a little more than the figure I have given. Have made this estimate from memory.

Am acquainted generally with Cache la Poudre Valley. Resided

at Fort Collins. Was County Commissioner of Larimer County at one time.

La Porte district is in no way peculiar or different from rest of Poudre Valley. With same class of farming, don't see why whole valley cannot be handled as well as that portion is. There are portions that would not be quite so good, but think larger per cent of land along Poudre is capable of raising crops we have.

3261 We raise beets in that district as successfully as in rest of Poudre Valley. Do not raise very much grain. We cannot afford to. Ground is worth too much for these other purposes. You cannot afford to raise alfalfa and grain on $400 to $500 land. If we did we would lose money. Grain and alfalfa would grow just as well there as in any other part of valley. There is a little alfalfa grown here and there and some grain but not very much.

Same system of intensified farming could reasonably be expected to prevail over larger areas in Poudre Valley if development was such to bring it about. This intensified farming extends in general way from Fort Collins up the river. Any of the ground near the river not only can, but always has raised as good onions and cabbage and like crops several miles this side of La Porte as well as at that place.

3263 Redirect examination by Mr. Fred Farrar:

La Porte is oldest settled district in Poudre Valley. It was the old overland stage station and we have some of those old buildings there yet. It was camping place for soldiers before they camped where Fort Collins was later established. Think La Porte postoffice was one of very first in Northern Colorado, if not first outside of Denver.

A piece of land in La Porte district with boulders coming very close to surface that had never been considered valuable at all, and was practically raw, was lately sold. It had practically no improvements. They tried to grow alfalfa on it but failed. Last year Mr. Lambert put some apple trees on it, just one year's growth. It is a three cornered piece lying just northwest of our new school building. It contains three and a fraction acres. It sold a few days ago for $1200 spot cash, practically four hundred dollars per acre. Do not know of any recent sales of improved orchard lands in that vicinity.

3264 In La Porte district we have consolidated school in which five districts were consolidated into one. Last year we constructed strictly modern school building with heat, light and water and same system they have at Fort Collins. We have seven teachers and have seven teams that go and haul all of pupils in in morning and take them home in evening. Think about 300 pupils attend in all grades. The course includes high school. We prepare for entrance to College. Our high school is accredited so that graduates enter college without examination except exactly same as the city schools at Fort Collins. Practice of sending out conveyances and getting school children and bringing them in is rather new here. Until

I commenced looking it up in Government reports, supposed it was new generally. It has been thoroughly tried and in every case has been a success.

Our school building cost $25,000. It is three story building.

Mr. Pennock has been engaged quite extensively in or-
3266 chard business for a good many years. He is in what is called Pleasant Valley district. I do not intend to make any definite limits on La Porte district but rather to speak of whole area which ships produce out of La Porte station. Intensive farming extends clear to Fort Collins and beyond in greater or less degree.

Stages which crossed river at La Porte were on what was known as Overland Stage Line that ran here in early day. They went up through Virginia Dale and must have gone through Laramie. It is same route followed in general way by wagon road today.

There has been rather intimate connection between La Porte section and Laramie Plains for a great many years. There has been interchange of garden produce for live stock and so forth.

FRANK L. WATROUS.

Direct examination by Mr. Fred Farrar:

Reside 1½ miles northwest of Fort Collins, Colo. Same here in 1871 and this has been my home ever since, although I have been absent on one or two occasions, once for one year in Wyoming, another time one year in Texas and four years at Rocky Ford, Colo.

3268 County Commissioner Larimer County. Have been associated with experiment station of Agricultural College. Began work for college 1887 on Rocky Ford Station in the Arkansas Valley and remained there four years. That station was devoted to experimentation generally in farm, garden and fruit crops. After that was associated with college here to take place of man who left farm department and was appointed assistant agriculturalist. Was so connected with institution here a little over eight years. Total of twelve years with institution.

At present engaged in raising fruit about four miles from La Porte and between La Porte and Fort Collins. Have tract of nine acres which I am getting into fruit. Commenced about four years ago. Have about four acres now in fruit. Have apples, pears, plums, cherries, raspberries, strawberries, and black and
3269 white currants. Orchard just beginning to bear. Agriculture in my vicinity is mixed, quite a little gardening, considerable fruit raising and quite an area of peas, alfalfa, wheat, oats and barley. Market gardening and fruit raising to quite an extent.

In my vicinity we have finest celery farm in Larimer County and have some fine raspberry patches and good orchards. Orchards of apples, cherries, plums and several large raspberry and strawberry patches. The C. R. Evans of forty acres is situated about one-half mile from my place and between me and La Porte.

Celery yielded about $800 from 1¼ acres last year on Adolph

Anderson place near me. Celery has not been cultivated to large extent. Anderson has grown celery on this same farm for last fifteen years successfully. It is marketed locally to large
3270 extent but a great deal is shipped to Cheyenne, Wyo. Soil in my vicinity is of equal quality with that of the La Porte district varying only in its nature. My immediate vicinity is as well adapted to raising of market garden products, fruits and vegetables and general intensive farming as is the La Porte District.

Quite familiar with Laramie Plains region in Wyoming. Have traveled over there great many times during last 35 years, and know nature of country. Resided near what they call tunnel near Laramie River off and on for 2 or 3 years and used to travel across Laramie Plains to Laramie City, from Laramie City to Fort Collins, and owned ranch at St. Cloud and traveled from St. Cloud to Laramie and Tie Siding, Wyoming. The tunnel near which I resided is situated directly west of Wheatland, Wyoming, and is the tunnel through which water from the Laramie River is di-
3271 verted for irrigation of Wheatland tract. I resided in mountains on Slate Creek. While there did my trading sometimes at Laramie, sometimes at Cheyenne and sometimes came clear down to Fort Collins. Also traded at Uva, a little settlement on Laramie River north of Wheatland. St. Cloud is about 35 miles southeast of Laramie in Colorado. While living there, traded frequently at Laramie.

Would not call Laramie Plains a farming country. There is no comparison at all between that region and the Poudre Valley in Colorado. Have not been through Laramie Plains Region overland during past nine years but went through on cars during that time. My testimony from personal knowledge of conditions is of those prevailing prior to last nine years. It is a great big plains country with nice grass and a good range for stock. It produces live stock. I have seen a few patches of rye, a few patches of potatoes, perhaps just a little garden in way of cabbage and some
3272 hardier vegetables near houses. These gardens were just small patches. I never saw any alfalfa growing there but have understood there was some.

Fruit and market gardening district of Cache la Poudre Valley is not confined to La Porte district. I do not know of any reason why same system of cultivation and same products could not be raised in other places up and down Cache la Poudre Valley, that are now raised at La Porte. As valley broadens out we have what we call first, second and third benches. Each bottom rises from one below. There is difference in quality of land each area being better adapted to certain crops. Lands right on river bottom where it is free from seepage and is good alluvial land, is of same quality as soil at La Porte and just as well adapted to market gardening. That same condition prevails clear down to Greeley. Market gardening, particularly raising cabbage, onions and crops of that nature is quite extensive at Greeley and in that vicinity. As you rise to next bench, my place is on second bench, we have a little more

clay, it is just as good for some things, better for strawberries, apples and some other fruits than is the first bench. It is not quite so well adapted to celery, onions and some of these garden products but is better for fruit. On third bench we have a little more clay, which
makes it better for apples, wheat, oats and other agricultural
3273 products. Early settlement of La Porte Valley district is
reason for intensive agriculture there. In early settlement of country little ditches could be taken out and a small body of land put under cultivation and there was a large market for things they could raise there. La Porte was closest point to Laramie and Cheyenne and the land has been cut up into smaller patches and at an earlier date than the rest of the valley. People could make a living up there on a smaller piece of land than in lower stretches of the valleys.

Markets at Cheyenne and Laramie contributed to this condition. Think it was also due to fact that number of ditches were taken out up there. It is quite important to gardeners to have water handy and, being close to head of ditches, they had less trouble in successful gardening.

Canal of The Water Supply and Storage Company, commonly known as Larimer County Ditch, heads a few miles above La Porte. Canal of The Larimer and Weld Irrigation Company, commonly called Eaton Ditch, heads a few miles below La Porte, a few miles above Fort Collins. There are other ditches that irrigate on south side of river and head in same general vicinity. As matter of fact, larger ditches which irrigate upper end of Poudre Valley and even those which extend into Weld County, to some extent, radiate from
this point and extend in fan shape from this common point.
3274 On south side of river there are the Pleasant Valley and
Lake Canal, called the High Line; the New Mercer, the Larimer County No. 2 and the Arthur Irrigation Company ditches. On north side of valley there are the Poudre Valley Reservoir Company Canal, now a part of the Greeley-Poudre Irrigation District system, the Larimer County Ditch of The Water Supply and Storage Company and the Eaton Ditch of The Larimer and Weld Irrigation Company, together with a number of smaller ones.

FRANK L. WATROUS.

Cross-examination by Mr. N. E. Corthell:

3274 I lived in Wyoming for a year or so in 1886 at the head
of Slate Creek, seven or eight miles east of the Wheatland
3275 Tunnel, and used to travel to Laramie and from Laramie
along the railroad to Tie Siding and then to Fort Collins. Excepting possibly for some few ditches to irrigate meadows, none of the country through which I passed on these trips was irrigated land, and there were only a few narrow strips of irrigated land along Slate Creek. I was not familiar with the land lying west of the Laramie River and along the Little Laramie River. My land near Fort Collins has quite a little clay in it, being on the first bench

above the river bottom, and such land is considered better
3276 adapted for apples, strawberries and cherries than the river bottom land, which has less clay.

Redirect examination by Mr. Fred Farrar:

My farm has nine acres. Family consists of wife and one small son. This nine acres furnishes livelihood for my family. Just commenced on land 4 years ago. Am putting it into fruit as
3277 fast as I can. It takes several years for fruit to come into bearing to make it what we call a paying proposition, and it is only during last two years I got place in shape so I could figure we were making living off of it.

C. P. GILLETTE.

Direct examination by Mr. Delph E. Carpenter:

Reside at Fort Collins. Am connected with Colorado Agricultural College and with Agricultural Experiment Station. Am head of Department of Zoology, including Entomology. I am also director of Experiment Station. Have been director three years. Succeeded Professor Louis G. Carpenter. Came to college in January, 1891, as head of Department of Zoology and Entomology and Entomologist of Experiment Station. Was raised in Michi-
3278 gan and received my college education at Michigan Agricultural College. Was assistant in Department of Zoology and Entomology in that institution about 1½ years after graduation. Was raised on farm. Have been identified with agriculture throughout my lifetime. After leaving Michigan Agricultural College went to Iowa Experiment Station at Ames. Was Entomologist of Experiment Station there for not quite three years. Came from there directly to Agricultural College in Colorado.

Have been a member of American Association for Advancement of Science since 1888. Have been a Fellow in same Society for fully 20 years; a Charter Member of the American Association of Economic Entomologists and a member of several minor scientific societies from time to time.

3279 Published a few bulletins in Iowa Experiment Station while I was there, wholly along Entomological lines and have published several bulletins in connection with this institution. Have published one scientific paper for Smithsonian Institute on insects on the Jessidæ of Colorado (Typhlocybynae). We commonly speak of these insects as leaf hoppers, the small sucking insect that takes foremost part in failure of plants. I have published a number of scientific papers also on plant lice. Have made a specialty of the study of plant lice.

My work as Entomologist has kept me constantly in touch with agricultural and horticultural conditions and conditions of general crop development through states in which I have been engaged. I am State Entomologist for Colorado. My duties as Entomologist for the College and for the State cause me to travel a great deal over Colorado and adjacent territory, especially in fruit growing

districts, beet growing districts and wherever agriculture is somewhat intensified. Where agriculture is most intensive, we have most trouble with insects. Have been familiar with agricultural sections of Colorado throughout my employment with College since 1891. My investigations have taken me into regions of high altitude as well as those of lower altitudes. On some occasions have gone to San Luis Valley to investigate insect troubles, that is one of our higher agricultural regions of Colorado.

3280 Have been especially familiar with Cache la Poudre Valley during the term of years I have been with College, also familiar with development of the region. The only real visit I made over the Laramie Plains region in Wyoming was about July 14, 15 and 16, 1913. Made this trip of inspection with Professor House and Professor Freer of college faculty. Professor E. B. House is now at head of engineering department. Professor Freer was at that time with Agronomy Department and also beginning to act as state agent for Government farm enlargement work. That involved a series of studies regarding farm economics. During this trip of inspection, traveled more or less over Laramie Plains region. We left Laramie and went directly to Lake Hattie, by way of what they call the higher road and from there across country to Sodergreen Ranch. From there to Woods Landing and from that point by lower road went back to Laramie. Also went over other portions of

3281 Laramie Plains on succeeding day. During second day of inspection on Laramie Plains, made a trip to Little Laramie Valley. Went from Laramie over intervening mountains to Wheatland and from there back to Cheyenne.

My general impression of Laramie Plains region, according to my notes made at the time, was that the country was only adapted to grazing and that it seemed to me they were attempting to spoil a good grazing country by trying to farm it. Native grasses seemed to be slow in coming in again where lands had been broken. After spending the day I mentioned, leaving Laramie, going to Lake Hattie and from there to Woods Landing and back again by lower road to Laramie, according to my notes, we did not see even a fairly good farm crop during the day. The best crop we saw was that of barley near Mr. Grable's house on lower road. There were parts of that field which I estimated might yield from 15 to 20 bushels per acre, but there was quite a large portion of field that would yield little or nothing and my estimate for whole field was that yield would probably not exceed 7 or 8 bushels per acre, that may be a little

3282 low, I am not sure. Best alfalfa we saw on that trip was also there at Grable place or near-by. We spent quite a little time in alfalfa field looking over stubble. The stacks were small and from estimates I decided yield could not exceed one ton per acre for whole field in that cutting. Cutting of alfalfa was nearly complete. Most of hay was in stack. From portion of field they were hauling to stack. It must have been first cutting of alfalfa. It was middle of July. It could not have been second cutting. Remember visiting Hart Ranch where they were also putting up hay. Impressions were practically the same there. Remember only other field of grain

which I saw that I thought would possibly pay for care of crop was field of unirrigated rye, where we estimated there might be 5 or 6 bushels per acre harvested. It seemed to me that all other crops they were attempting to grow were really a dead loss, they could not get back the money that they had put into the crop.

First problem of agricultural development is to obtain from soil crop returns sufficient to meet expenses of cultivating ground and harvesting crop. Returns must be more than that before they could make profit out of the work. It is not to be taken as probable that, because plants will grow on a certain territory, they will therefore yield net returns to the farmer.

3283 Observed native hay growing in Big Laramie Valley on Riverside Ranch region and down the river from there. Growth seemed to be pretty fair. We drove for some distance through one strip of country where they were growing native hay, but even there crop did not seem to me to be heavy, it seemed to me that profit would be in growing of native hay and in grazing on country adjacent. My conclusions in this regard were confirmed on second day's trip over Little Laramie region.

My general conclusions were that the Laramie Plains is a grazing territory. It is a region adapted to the growing of animals rather than the finishing for market. Would hardly think it suitable for finishing animals without the growing of considerable grain.

Attributed condition of country to cold climate and short season. Country is high to begin with, being pretty well north, and they necessarily have a short, cold climate with cold nights which limits plant growth. I might say in addition to that, that over a good deal of country through which we passed, there was a very gravelly soil which of course is not strong soil for agricultural purposes.

Where coarse gravel came near surface land is hard to cultivate. There is considerable land where cultivation could be carried on very well. The land does not respond to cultivation very rapidly. Even in better land which we found, where gravel is not so coarse, land does not cultivate so economically as do the soils of the Cache la Poudre Valley.

Do not think I saw any land that would compare favorably with most of land in Cache la Poudre Valley.

Was impressed with fact that we traveled over country where there were old irrigating ditches and passed many laterals of considerable size that were apparently unused. It seemed strange to me that a country that had had irrigating ditches for something like 35 years was still lying unirrigated. No crops to speak of growing on land. We also noted on that day a considerable number of alkali lakes where their irrigating water seemed to be collected and from which there seemed to be no possible means of getting water out again. This seemed to be rather a bad condition in region.

3285 Soil auger was used for boring holes in earth in the country visited by party. The Water plane in many places was close to surface. I did not pay much attention to that. Think it ran from 3 to 5 feet through a good deal of the territory. Think that was true on Hart Ranch also. Test for soil and water plane

was made in alfalfa field on Hart Ranch. It was in one of the best fields that we saw.

As an entomologist I observed a peculiar characteristic indicative and confirmatory of my views obtained from reconnaissance of the area. I could not help but observe the insect life and make some conclusions on the trip. I recall especially some observations of one of the plant lice on the cottonwoods up there where all of the broods of the season were gathered in one gall, indicating that the insect must pass through its life history in a very short time. Not only was the stem mother, that is the louse that starts the broods for the season history, in the gall but the entire broods of the season, including the a-sexual forms were all in the same gall.

This was indicative of very short season in which the lice had to pass their life histories. Otherwise they would have escaped and produced from other forms, but finding the whole life history in the same gall, indicated that they were living in a cool climate
3286 with a very short season in which to go through their transformations. This I concluded from observations actually made on the ground during the trip.

Possibilities of the Laramie Plains region increasing in population and supporting a large number of people are very small, compared with Cache la Poudre Valley. This I concluded from crop observations I observed, the short growing season and the limitations they must have of crops that could be grown because of their short, cold climate. It seemed to me the area was limited practically to grazing. That is not regarded as a profitable industry when confined to small areas.

I see no reason why Cache la Poudre Valley should not develop into an area of dense population. It has an excellent, deep soil, and, with water to irrigate it, I see no reason why it should not be as productive as any section that can be found almost anywhere in the country. In fact, when I go out over other sections of the country, I come back to Colorado thinking that I am coming back to the best agricultural section. I am familiar with the best agricultural sections throughout the Central States as well as the Rocky Mountain Region. I make this statement having in mind these other sections.

Population on irrigated area of Cache la Poudre Valley has been steadily increasing since I came here in 1891. This is indicative of the future increase of the population of the valley.

3287 Cultivation has been improving since 1891. Farms are better cultivated. Farmers are keeping up fertility of soil better than they did a few years ago. When I first came to Colorado, farming seemed to me to be very slip-shod and shiftless, while today farmers are conserving their manures and rotating their crops better and are building and retaining fertility of soil. Cultivation is more intense and on a better scale than it was.

Units of land cultivated by various farmers and families are becoming smaller. That is to be expected.

I do not believe the individual holdings in the Laramie Plains region are liable to decrease. I do not think that smaller holdings can be profitable to the owners. In fact, I should be surprised if

holdings up there do not become larger in those sections where they have been selling land for agricultural purposes. This will come from a failure to make a living on their farms where they are trying to grow grains, alfalfa and farm crops, in my judgment. In other words, the net return from the land will not be sufficient to warrant an attempt to cultivate smaller areas by families.

3288 So great a variety of productive and profit yielding crops cannot be cultivated in a region of the climatic conditions of the Laramie Plains. I think the number of crops that could be grown upon Laramie Plains as compared with Poudre Valley, would be very small indeed, no matter to what extent they might try to carry crop improvement and production of new varieties. The production of plants of any kind to stand severe climate is very slow process. There would be many new plants found which would be adapted to cultivation in the milder climate where one would be found that would withstand the severe climate.

An acre foot of water will bring a much greater return, both to the farmer and to the community, in the Poudre Valley than it will on the Laramie Plains region.

C. P. GILLETTE.

Cross-examination by Mr. N. E. Corthell:

3288 Excepting when passing through on the railroad, I have never traveled across the Laramie Plains excepting one trip
3289 I made in July, 1913. The first day we did no more than drive to Laramie City, and the next day we drove up to Woods Landing, stopping at Sodergreen's and one or two other places, and on the return making several stops.

3290 The return trip occupied the next day, and the following day we went to Wheatland. The gravelly condition of the soil was most noticeable from Lake Hattie up to Sodergreen's, and then from Sodergreen's down to the Grable ranch. From the Grable ranch into Laramie, conditions were better, and I
3291 recall finding no gravel. We inspected some fields of oats, and saw some wheat and rye, but the oats and rye were not headed out, but I do not recall seeing any truck crops of any kind. We noticed but did not make any careful examination of
3292 some of the plots in the experiment station farm. The soil between Grable's ranch and Laramie City is quite similar
3293 to the lighter soil in the Poudre Valley and not quite as heavy as our heavy clays. I would compare it to the soil in the vicinity of Greeley, Eaton, and Ault, which are good potato, beet, grain, and alfalfa soils. Some rather large laterals which may have been main ditches, and some smaller laterals were noted
3294 above Sodergreen's ranch, which appear to have fallen into disuse. I do not know the names of the ditches nor who they belonged to. My examination was not sufficient upon which to base a reliable judgment of the agricultural possibilities of the country.

3295 Redirect examination by Mr. Fred Farrar:

Professor E. E. House was with me when these soil samples were taken.

Even if I were to examine that country for one, two, three, four or ten seasons, I could not alter the climate or the elevation. Even if certain portions of Laramie Plains had soil conditions as good as those in Poudre Valley, that would not alter the climate nor the elevation. I considered the bad agricultural conditions there due really to their short, cold climate chiefly, but also directly to their poor soil over a considerable part of the section.

Whether or not plots at Experiment Station grounds are indicative of economic probabilities or possibilities, depends on what the real object is in growing the plots. If they are attempting to show what could possibly be done with very best care and fertilization of soil, that would mean one thing. This I presume was what they were doing there, they appeared to be show plots, a favorable piece of ground near buildings.

The second day of the trip was devoted during the morning to the section between the Grable Ranch and Laramie and the balance of the day was taken up in investigation of Little Laramie area. I remember going down Laramie River on west side as far as Bosler Station and through what is known as Talmadge-Buntin tract. My general conclusions that I have given cover that area as well as the other.

3297 Redirect examination by Mr. Delph E. Carpenter:

Found better agricultural section around Wheatland than around Laramie, apparently very much better.

Do not remember seeing any painted farm houses in Laramie Plains region outside of new house of Mr. Grable and houses immediately west of Laramie in suburbs near Experiment Station. Just before turning to go directly into Laramie, on our left, there were 2 or 3 little houses that were painted, otherwise I do not think they were painted.

3298 B. F. HOTTEL.

Direct examination by Mr. Fred Farrar:

Lived at Fort Collins, Colorado, for 35 years. Engaged in milling business principally during that time, flour milling. Connected during that period at one time with Mason & Hottel, later B. F. Hottel and later succeeded by The Fort Collins Milling and Elevator Company. Was manager of latter company. Company owns mill at Fort Collins called Lindel Flour Mills. Mills on present site have been destroyed twice by fire.

Original mill constructed — Fort Collins in 1867, operated mainly by water power. We have an appropriation of 90 cubic feet per second for water power from Poudre River.

We are unable to secure enough water at all seasons of year to

supply this 90 cubic feet per second. During part of winter
3299 season do not have sufficient water to suply this amount. Operate the mill by steam during that time.

Appropriation for water power is in April, 1867. None of the larger ditches in vicinity of Fort Collins have a full appropriation earlier than that. Earlier appropriations are small ditches.

Engaged in milling business when — came here 35 years ago. That was my business until January, 1913. Am no longer manager of mill but still interested in mill same as I have been.

Production of wheat in vicinity during period I have been here varies somewhat. During first year's production was about 200,000 bushels and ranged from that up to 500,000. There has
3300 been a gradual increase in acreage devoted to wheat. About 15 years ago yield had dropped off to about 18 or 20 bushels per acre. Since that time yield has come up to about 30 bushels per acre on average. Have known wheat to produce as high as 70 bushels per acre. Yield in bushels per acre decreased about 15 years ago on account of wild oats that had gotten start in country. This has been mostly eradicated. Beet production has had good effect on growing of wheat. It has cleaned up ground and put it in better condition due to careful farming and fertilization.

There are two flouring mills at Fort Collins now. In addition to these mills there are elevators that are not connected with them, three elevators. There is elevator at Wellington, and one at Timnath.

Wheat is exported from Poudre Valley. It is shipped from these points we have named. We import wheat at our mill mostly from Idaho in order to blend it with our Colorado wheat, it makes a whiter, softer and more desirable flour for southern trade. This importation is because of different quality of Idaho wheat.

Wheat produced in Cache la Poudre Valley is of good quality. Our northern wheat generally runs over 60 pounds per bushel, 61-2 or 3 pounds. Most of spring wheat runs about 60 pounds per bushel.

Our mill has capacity of 300 barrels of flour per day. Flour is usually handled in sacks in this region. A sack of flour weighs 98 pounds net. It is one-half of a barrel.

We ship flour from Fort Collins to Wyoming. Laramie, Wyoming. We ship about 2 carloads of flour per month to Laramie, Wyoming. A carload is about 30,000 pounds. Have made shipments of flour to Wyoming ever since I have been in milling business.

We also ship flour to other points, to southern states and
3302 as far as old Virginia.

3303 Redirect examination by Mr. Fred Farrar:

This mixing of Idaho with Colorado wheat is to supply a popular demand for a certain kind of flour in certain markets. The importation of this outside wheat has only been made during last 2 or 3 years at this mill. Do not think we bought any wheat from Idaho last year but we did before, in 1912, I will look that up and find out exactly.

Examination by Mr. Corthell:

In my statement which I will hand to the reporter, I will include all of the wheat imported by me from any point outside of the Poudre Valley.

3304 Examination by Mr. Fred Farrar (continued):

My statement will apply only to wheat purchased at my own mill. It will not be a statement as to other mills or other elevators in valley.

The statement furnished by Mr. Hottel, is as follows:

Aug. 27, 1894, to	July 31, '95	Colorado wheat.....	4,558.477	Lbs.	Wheat
July 31, 1895, to	Oct. 5, '95	" "	1,774,658	"	"
Fire.					
Oct. 5, 1895, to	Aug. —, '96	No purchase.			
Aug. 1, 1896, "	Aug. 16, '97	Colorado wheat.....	6,168,170	"	"
Aug. 16, 1897, "	Aug. 15, '98	" "	8,593,739	"	"
Aug. 15, 1898, "	Aug. 12, '99	" "	10,637,660	"	"
Aug. 12, 1899, "	Aug. 11, '00	" "	8,640,685	"	"
Aug. 11, 1900, "	July 27, '01	" "	9,463.415	"	"
July 27, 1901, "	June 21, '02	" "	7.640,690	"	"
June 21, 1902, "	" 22, '03	" "	5,795,385	"	"
June 22, 1903, "	" 18, '04	" "	7,374,442	"	"
June 18 1904, "	" 30, '05	" "	5,902.647	"	"
June 30, 1905, "	" 30, '06	" "	8,857.885	"	"
June 30, 1906, "	July 6, '07	" "	8,906 815	"	"
July 6, 1907, "	June 20, '08	" "	8,532,995	"	"
June 20, 1908, "	" 19, '09	" "	3,308 102	"	"
June 19, 1902, "	" 25, '10	" "	6.787,487	"	"
June 25, 1910, "	" 17, '11	" "	10,352 640	"	"
June 17, 1911, "	" 8, '12	" "	12,835.269	"	"
		Idaho "	846,601	"	"
June 8 1912, "	" 16, '13	Colorado "	10,900,480	"	"
		Idaho "	160.000	"	"
June 16, 1913, "	Feb. 28, '14	Colorado "	11,390,165	"	"
		Idaho "	3,457.645	"	"
Total Colorado Wheat.....			157.521,805		
" Idaho "			4,484,246		
			162,006,051	lbs.	

3305 DENVER, COLORADO, March 9, 1914.

W. L. PETRIKIN, Denver, Colo.

Direct examination by Mr. Delph E. Carpenter:

Vice President of The Great Western Sugar Company. Identified with corporation since 1905. Identified with sugar business since 1902 at which time commenced at Eaton, Colorado. Entered sugar business at Eaton as scale man, weighing beets in 1902. Identified with Eaton sugar factory until Spring of 1903. Then became identified with factory at Windsor in capacity of cashier until spring of 1905. Was called to Denver office as chief clerk. Since that time have acted as Secretary of The Great Western Sugar Company

part of time, first as director and as secretary and then later as
3306 Vice President. Was Secretary for about 5 years.

Prior to entering sugar business was located at Eaton, Colorado. There about 9 years. Five years of time in employ of Ex-Governor Eaton and four years in mercantile business. During time was in employ of Ex-Governor Eaton became thoroughly familiar with general administration of lands in Laramer and Weld Counties belonging to Governor Eaton and his associates, so far as I looked upon term "familiarity" in those days. Since that time have kept in touch in large measure with agricultural development of Cache la Poudre Valley in northern Colorado in particular. During time have been connected with beet sugar business it has been my special line of work to keep in touch with agricultural development and live stock industry in northern Colorado.

Research work of my company has extended to question of study of feeds and balanced rations and endeavoring to make experiments along certain lines to demonstrate practicability. The purpose of these investigations have been two-fold, first for purpose of making more money in feeding of stock we had in our own control and second gaining information to give growers of beets, so they could profit to greater extent by use of bi-products of their crops.

3307 It has been policy of The Great Western Sugar Company to give preference in disposal of by-products to the growers. This has been universal policy in some sections. In what we call Platte River Valley it has not been to same extent, because we had an unfavorable experience there in first 2 or 3 years and on account of uncertainty of growers consuming by-products of factories each year. Under six northern factories, it has been universal practice to give growers of beets preference of by-products.

Factories at Eaton, Greeley, Windsor, Fort Collins, Loveland and Longmont go to make up the six factories of northern Colorado.

The pulp in most of territories is consumed within distance of about 4 miles from factory, up until last year when some of the territories distributed pulp to distance of 8 or 9 miles. It is principally confined to the zone naturally determined by economical wagon haul. There has been some but no great amount shipped by rail.

Best pulp is fibre of beet that is left after sugar is diffused from the fibre. Sugar is diffused from fibre by use of hot water and
3308 steam. Beets are sliced before going into diffusion batteries. They are sliced into what we call cossettes. These are slices that are serrated, so as to dissect and bring into contact with the water the greatest part possible of the sugar beet slices. After sugar has been diffused fibre passes into what we call pulp and is put into a pulp silo. The pulp silos are large excavations which are floored at the present time with 2 x 4's on edge and the sides are covered with planking. Through the flooring at different intervals there are drains. These drains are constructed to allow surplus water in pulp to pass off into sewer. The pulp is conveyed to these silos by centrifugal pump and water. It is screened on top of flume and greater amount of water taken out. Pulp is transported from silos to place

of feeding mostly by team and wagons. Teams and wagons drive into silos for purpose of loading.

Molasses is another by-product produced at factory and used for feeding of live stock. It is what we call a refuse molasses and when we discard it, it contains about 50 per cent. of sugar, but together with so many impurities that it is not economical to extract any greater amount of the sugar with any process that is econom-
3309 ical in this territory. It is principally a carbo-hydrate feed. It is used as a substitute for corn or other grains.

Demand for this molasses from other localities than in immediate locality of factory, is greater than we can supply. We had offers for about 15,000 tons this year that we could not supply. These offers come from molasses feed manufacturers, situated on the Missouri River, St. Louis and points in Illinois and Indiana. If we had accepted these offers in lieu of giving first option to growers this year, we would probably have obtained an average of close to $3 per ton more than we did from the growers. I think it is a fact that we could export our entire output of molasses outside of Colorado territory, if it were not for our policy of permitting it to be consumed of immediate vicinity of factories.

Molasses and syrup also act as a general conditioner for animals They act the same as condition powders, to make it plain. I would state that Mr. T. B. Hoard of Central City, Nebraska, who is one of largest outdoor feeders in the state, stated to me the year before he died that he would use molasses at the price it was costing him at that time which was $23 per ton by time it reached the cattle, rather than to use corn to the extent of 3 or 4 pounds per day, regardless of how cheap the corn got in the country, for
3310 benefit he received in performance of other foods outside of that of molasses. There is no question but that molasses acts as a conditioner and permits a greater absorption of nutritious values from other foods. My conclusion is based on practical observation rather than any scientific proof I could produce on the subject. The same is true of beet pulp, but probably to a greater extent.

Alfalfa is the principal food that is consumed in northern Colorado region along with sugar beet pulp and syrup. In some cases cotton seed meal cake is used. Cotton seed meal cake is a formation of concentrated food for supply of proteids. Cattle on full feed will consume from 2½ to 4 pounds per day per head. The purpose of cotton seed cake is to supply deficiency of protein occasioned by feeding of syrup or pulp or food carrying carbo-hydrates principally.

About 12 pounds of alfalfa hay per head per day is consumed by cattle who are at the time time fed all of the syrup and pulp and cottonseed cake necessary to balance the ration. These cattle would then be consuming about 5 pounds of syrup and about 95 pounds of pulp per day on average. Sheep and cattle principally are
3311 fed on these two by-products of sugar beet industry. Quite a large number of these are fed on grounds immediately adjacent to factory.

Fertilizer remaining in feed yards near factories and elsewhere in

vicinity, in northern Colorado district, is disposed of to beet growers adjacent thereto. It forms a considerable factor in benefits derived from feeding operations.

Best tops constitute another by-produce of sugar beet industry fed throughout beet growing districts. The beet top is the stem, leaf and part of the crown of the beet, that is cut off and left in the field. The crown of the beet is cut off and left with the tops because it carries such a low percentage of sugar that it is not economical to attempt to extract the sugar therefrom. This by-product, the beet top, is left in the immediate possession of the farmer or in other words is retained by him. The factory does not exercise any control over these beet tops. Up until very recently, they were pastured by sheep and cattle, just allowed to lie in the fields and be pastured off after the beets themselves had been hauled from the field. There has been a change in this method of feeding. They are attempting at present time to use them in a more economical way, first by hauling tops in and using them as they would hay and second by siloing them and using them in form of silage. It has been the
3312 observation of farmers that this newer method is much more efficient than the former when considered from the standpoint of values obtained from the tops.

In early history of beet sugar industry value of beet tops as stock food was not realized by growers. Progress in this regard has been rather slow. The tops are supposed to equal about 75% to 80% of the weight of the beets that are harvested and marketed. For example a fifteen ton crop of beets as delivered to sugar factory would leave in the field about twelve tons of beet tops. To express it in another way, where farmer obtains 16 tons of beets off of an acre of land and hauls them to the factory, he also obtains about twelve tons of sugar beet tops which he keeps in his field.

During recent years farmers are obtaining much higher benefit from beet tops than by pasturage methods. The extent of this benefit in dollars and cents I cannot give because I cannot rely on data given me by those who have done it to any great extent.

The theoretical feeding value of beet tops, as compared with some other feeds used with alfalfa hay and corn, has been worked out for me and furnished me. I have this data with me and will read it into the record:

3313 *Value of Beet Tops.*

"The weight of green tops and leaves of an acre of sugar beets averages about 75% of the weight of beets harvested. In years with wet falls it is considerably more than in years with dry falls, or when leaf diseases destroy leaves it is less. Therefore, a crop of 16 tons of beets per acre will average about 12 tons fresh tops and leaves. This is in addition to the weight of the beet itself.

Henry in "Feeds and Feeding" page 589 (the recognized American authority), gives as his analysis of Sugar Beet Leaves, the following: 12 percent. dry substance; 1.9 percent. crude protein digesti-

ble; 5 percent. carbo hydrates digestible; 0.2 percent. fat; making 7.1 percent. total digestible nutrients.

The same authority gives the following analysis for Dent Corn: 89.4 percent dry matter; 7.8 percent crude protein digestible; 66.8 percent carbo hydrates digestible; 5.3 percent fat; a total of 78.9 percent.

If the digestible part of the beet leaves, according to Henry, has the same food value as corn, then 1,110 pounds of leaves would contain the same amount of digestible nutrients as 100 pounds of corn. Or, one ton of beet leaves would be equal to 181 pounds of corn. If corn is rated at $1.10 per hundred, the average Colorado, price, the food value of one ton of leaves, based on the corn value, would be $1.99. The food value of one acre of leaves yielding 12 tons would be $23.88.

It appears, however, that Henry's analysis refers only to leaves and not to leaves and tops, the latter being a small part of the beet connected with the base of the leaves. This part has a higher nourishing value than the leaves alone since it contains sugar.

The German authority on this subject, O. Kellner, gives the following analysis for beet tops and leaves; 16.2 percent dry substance; 1.7 percent digestible crude protein; 7.0 percent digestible carbo hydrates; 0.2 percent digestible fat, which makes a total of 8.9 percent digestible nutrients.

On this basis one ton of fresh leaves and tops would contain the same amount of digestible nutrients as 225 pounds of corn and if one of the same value as corn at $1.10 per hundred, would be worth $2.25 per ton or $27.00 per acre.

On this basis an acre of beets yielding 12 tons fresh tops and leaves as by-product of a 16-ton beet crop would produce 2,136 pounds digestible food, equivalent to 2,700 pounds of corn or about 45 bushels of corn.

Hoard's Dairyman gives the total average yield of digestible dry substance from an acre of corn silage in Wisconsin as 3,600 pounds.

Timothy hay, according to Henry, contains, 2.8 percent. digestible crude protein; 42.4 percent. digestible carbo hydrates; 1.3 percent. digestible carbo hydrates, a total of 46.5 percent.

A yield of two tons per acre is considered high. This would give 1,860 pounds digestible food per acre.

Alfalfa, according to Henry, contains; 10.5 percent digestible crude protein, 40.5 percent digestible carbo hydrates; 0.9 percent digestible fat; or a total of 51.9 percent total digestible nutrients. Two tons of alfalfa per acre would contain 2,076 pounds digestible — per acre.

It is of course not quite correct to compare different feeds simply by the total amount of digestible nutrients they contain, as the feeding effect of the nutrients, for instance of corn and alfalfa, is certainly different. However, modern investigations give us a figure to do this. For a large number of feeds it has been determined by feeding tests, what amount of fat they produce in the animal body, in comparison with starch or carbo hydrates. On the basis of the

results of different feeds have been given what is called "starch value," a figure which expresses the pounds of starch necessary to produce the same amount of fat as 100 pounds of the food in question. This allows a comparison of the different feeds more easily.

The German authority, Kellner, gives the following starch values: fresh beet tops and leaves, 7.2; corn, 81.6; alfalfa, 26.5, Timothy hay, 29.1.

On this basis a ton of tops and leaves contains as much fattening value as 175 pounds of corn, or with corn at $1.10 per hundred, a value of $1.92 per ton, and with a yield of 12 tons per acre, $23.03 per acre.

A crop of two tons alfalfa would produce a starch value of 1,060 pounds per acre, equivalent to about 1,300 pounds of corn or $14.30 per acre.

On whichever basis the value of these tops is figured, it is considerable, although this fact was only recently generally realized by the farmers.

The comparative value of beet tops and alfalfa would also be found as follows:

At the experimentation in Fort Collins, the following results of feeding tests were obtained:—Pounds of food consumed to obtain 100 pounds gain in live weight, in A, it took 2,200 pounds alfalfa alone, C, 1,800 pounds alfalfa and 380 pounds corn.

On the basis of starch values, the 380 pounds of corn could have been replaced by 2.2 tons tops and leaves. The material for the production of 100 pounds of live weight, (with an acre yield of 3.5 tons alfalfa and 12 tons of tops) would have been produced on 0.26 acres alfalfa and 0.18 acres of beet tops, or a total of 0.44 acres.

If a two-ton crop of alfalfa alone, would have been used for the production of beef, it would have taken 0.7 acres to produce 100 pounds of live weight.

The tops are mostly utilized by pasturing them off. This is the easiest and probably the least efficient method. Between $3.00 and $5.00 per acre are usually paid for this pasture. That by this method not much higher values can be obtained is certain. Part of the leaves are tramped into the soil. Snowfall or rain make the tops inaccessible. The wind soon drys out the tops, transforming them into a horny mass which can hardly be chewed.

In the dairy districts around Fort Lupton and Johnstown, Colo., the farmers gather up these tops and feed them in the feed lot. None of these farmers assign a value of less than $12.00 per acre to these tops. Some go as high as $30.00. The reason that beet tops are not better utilized is that many farmers handle beet acreage up to the limit of what beets can be hauled by the number of teams on the farm. Therefore, there is no team labor available during beet harvest time.

The price obtainable for fat beef has been only during recent years high enough to stimulate rational and intensive feeding. The adjustment of farming systems to new price levels for the products is notoriously slow.

Summary.

	Basis pounds digestible food per acre.	Pounds starch value per acre.
12 tons beet tops	2136 pounds.	1728 pounds.
Equivalent to Corn	2707 pounds.	2105 pounds.
10 tons Corn silage (Wisconsin)	3600 pounds.	——
2 tons Timothy	1860 pounds.	1164 pounds.
2.0 tons Alfalfa	2076 pounds.	1060 pounds.

3317 This article on the subject of the value of best tops was prepared by scientists in employ of The Great Western Sugar Company. It was prepared by Mr. Hans Mendelson. At present time he is in charge of our beet seed raising and our experimental farm. He is a recognized authority on the subject of sugar beets and beet sugar.

The farmer is now approaching a basis of scientific feeding of beet tops as distinguished from the former wasteful and extravagant methods. There is evidence from year to year, of a better utilization of this by-product of the industry, to the extent that a great many of our growers say if it was not for the feed values of the by-products they would not engage in the industry at all.

The beet top is the only by-product which is distributed uniformly throughout the feed raising districts. It is the only one that is accessible equally to all growers.

It is difficult to state what per cent. of the sugar beet goes into the beet pulp. We actually recover from the silos in weight an amount sufficient to be about 27.31 per cent. of beet as introduced into the factory.

I could not give the value of beet pulp to the man who feeds it to stock. I have been offered $1 per ton. The factories receive on an average of about 65 cents per ton.

3318 $8 per ton is received by the factories for the syrup.

The northern Colorado sugar factories were constructed in the following dates: Loveland in 1901, Eaton and Greeley in 1902, Windsor, Fort Collins and Longmont in 1903, Sterling in 1905 and Fort Morgan and Brush in 1906. The Sterling, Fort Morgan and Brush factories are in the class commonly designated as the South Platte. The Fort Collins, Windsor, Eaton and Greeley factories are located in the Cache la Poudre Valley. Greeley also receives some of its beets from upper South Platte area between Greeley and Denver.

Acreage, tonnage and aggregate moneys paid to farmers or growers for years 1910 to 1913 inclusive for the four factories located in the Cache la Poudre Valley (Fort Collins, Windsor, Greeley and Eaton) and also the sugar production per acre for each of the factories during those years is as follows:

Eaton Factory.

Acreage:

1910..... 4,081;
1911..... 4,501;
1912..... 10,451;
1913..... 16,597.

Tonnage:
1910..... 51,886;
1911..... 61,930;
1912..... 160,965;
1913..... 217,889.

Money paid the Farmer:
1910..... $284,205.33;
1911..... 336,696.77;
1912..... 958,444.73;
1913 estimated..... 1,237,945.35.

Sugar per acre. This contains the approximate tons of sugar per acre in the beets harvested:
1910..... 2.05;
1911..... 2.19;
1912..... 2.55;
1913..... 2.04.

Greeley Factory.

Acreage:
In 1910..... 5,384;
1911..... 6,340;
1912..... 10,089;
1913..... 11,489.

Tonnage:
1910..... 65,515;
1911..... 84,487;
1912..... 121,727;
1913..... 137,484.

Paid to the farmers:
1910..... $361,182.56;
1911..... 474,106.37;
1912..... 739,253.91;
1913..... 778,215.60.

Approximate tons of sugar per acre in beets harvested:
1910..... 2.01;
1911..... 2.21;
1912..... 2.05;
1913..... 1.84.

The Windsor Factory.

Acreage:
1910..... 5,248;
1911..... 4,908;
1912..... 10,326;
1913..... 13,401.

Tonnage:
1910..... 64,285;
1911..... 58,446;
1912..... 138,931;
1913..... 172,876.

Paid to farmers:
1910..... $351,681.94
1911..... 320,883.07;
1912..... 821,364.27;
1913..... 975,819.89.

Approximate tons of sugar per acre in beets harvested:
1910..... 1.95;
1911..... 1.90;
1912..... 2.20;
1913..... 1.97.

Fort Collins Factory.

Acres harvested in—
1910..... 8,018;
1911..... 8,087;
1912..... 12,348;
1913..... 14,392;

Tonnage harvested:
1910..... 73,090;
1911..... 88,131;
1912..... 149,232;
1913..... 158,174.

Paid to farmers:
1910..... $392.215.27;
1911..... 487,957.41;
1912..... 875.478.83;
1913..... 875,698.72.

Approximate tons of sugar per acre in beets harvested:
1910..... 1.43;
1911..... 1.78;
1912..... 2.01;
1913..... 1.69.

I would like to state that all these figures do not pertain to exactly the same territory in each year, but the total acreage pertains to the total acreage of each year. There might have been some variation in the division between the factories in any separate year. In the aggregate it is compensating. There might be a slight variation from the rule I have given.

The variation would be owing to fact that in 1912 and 1913, and possibly 1911, there was rather a small acreage of beets grown at Wheatland, Wyoming, which is included in these figures.

Crop returns in beet tops to farmers for any year can be ascertained from the crop returns given, by computing 75% of the tonnage harvested. 75% of the tonnage as given by me in this tabulation.

It is necessary to employ a great deal of manual labor in connection with growing, harvesting and manufacturing sugar beets. Greatest amount of labor is hand labor employed in cultivation of beets. Sugar beet requires careful attention and high degree of cultivation.

Hand labor is used for blocking, thinning, hoeing, pulling and topping. That labor is employed by farmers at a stated price per acre. Customary price paid by farmers over a long period of years is $20 per acre. These laborers work largely under their own supervision. Of course farmer watches them and they are also supervised to some extent by the field men of the sugar company. About
3322 only concern farmer has is to see that work is done properly and at the proper season of year.

We have experts who have charge of these various districts, known as agricultural or field men. Their duties are to give what information is possible to the farmer, how to grow beets so as to obtain greatest tonnage per acre containing the highest sugar content and to supervise as nearly as possible agricultural methods, to see that this result is obtained at lowest cost possible.

It most assuredly is to the advantage of the Sugar Company to have profitable returns to the farmers, because it simply means that the more profit we can accrue to the farmer, the more productive the industry is.

3323 The team work is usually done by the farmer and is under his immediate supervision and is controlled entirely by him. Really all the work is controlled by the farmer. The agricultural experts do not pretend to supervise the work. He advises to quite an extent in reference to all work. It is up to the farmer to take that part of the advice he sees fit.

We employ a great number of men during receiving season at the receiving stations in capacities of scale men, dump men and tare men.

Method of receiving and weighing beets at dumps and obtaining tares and percentages is as follows: Load is first weighed over wagon scale which gives us gross weight of load. Wagon is then drawn over an elevated dump where load is dumped over gratings into a railway car standing on track at one side and below elevation of wagon when dumped. As the load of beets passes over the grating, a larger quantity of the dirt passes through the grating into a hopper and is there then weighed on a platform scale and is returned to what is known as the dirt screening device into the farmer's wagon. The farmer, if under the system of the dirt screening device, hauls the dirt back over the wagon scale and it is computed with the weight of his empty wagon to obtain the tare weight, the difference giving us what we call the first net. Just as the beets have passed over the grating, a sample is obtained by a crane with a basket or box.

3324 This sample is then weighed to obtain gross weight of sample. Beets are then removed, screened and re-weighed, which gives the first net weight of the sample, the difference being the tare weight. That tare weight is then computed on a percentage to determine what percentage it is of the gross weight of the sample. The per cent. obtained is used for the deduction of tare on the first net weight of the wagon. After this deduction, we obtain what we call our final net weight of the beets delivered.

Samples for ascertaining percentage of sugar are largely taken from same sample from which tare is obtained and are put in sacks, canvas bags, which are prepared as far as possible so as to exclude action of atmosphere, transported to the factory and there tested by analysis to determine sugar content, which sugar content determines the price paid the farmer for the beets weighed.

In this manner we keep daily accounts not only of tonnage but also of sugar contents of all beets delivered to the various factories from each individual grower.

Number of laborers employed in the field in growing the beets for

the Eaton, Greeley, Windsor and Fort Collins factories through years 1910, 1911, 1912 and 1913 are as follows: 3,247 for the four factories in 1910; 3,405 in 1911; 6,173 for 1912 and 7,982 for 1913. These are all laborers who do the hand labor in the field, and is exclusive of team labor. I obtained these approximate figures by first computing a certain number of acres per hand laborer and then checked it as near as possible with data we had on hand as to the actual number.

Number of employes at the four factories during the four years are as follows: 987 for 1910; 1,012 for 1911; 1,031 for 1912; and 1,087 for 1913. This does not include the employes at the dumps. The figures include just what we call factory employes, which means the laborers in the beet chutes and factories proper. It would not include office employes. In addition to these we have various clerical and office employes. This however probably includes the laboratory men.

Number of live stock fed on sugar beet by-products, pulp and syrup, at these four factories during four years 1910, 1911, 1912 and 1913, cannot be given very accurately, but I can give you number of cattle that could have been fed on by-products produced at these factories during those four years. This could be ascertained by the amount of by-products each year. Using this as a basis, number of cattle by-products would have fed during the four years at the four factories are as follows:

12,168 in 1910; 14,223 in 1911; 26,597 in 1912 and 28,820 in 1913. In arriving at this calculation I assumed one head of cattle for each five tons of pulp.

To ascertain number of sheep you will simply multiply figures I have given by 9 or 10, that is, 9 or 10 head of sheep equal one head of cattle. This of course does not include cattle, sheep or other live stock fed by farmers on beet pulp by-product.

About one ton of alfalfa per head for cattle would be approximately amount of hay consumed by these cattle during this feeding process. I am assuming an average feed of 150 to 160 days.

3326 Examination by Mr. Fred Farrar:

Not all the sheep and cattle fed in the Poudre Valley are fed on pulp and molasses.

Additional railway facilities had to be provided for handling the sugar beet industry, outside of the regular lines which entered the district. We constructed a railroad out of Loveland to Johnstown and I think first branch doubled back towards Berthoud and Wellington. Later it was extended to Longmont, Milliken, Windsor and Eaton. That is primarily a sugar beet road built primarily for that purpose.

Examination by Mr. Delph E. Carpenter:

I am not an official of this railroad company at the present time but have been during the past.

3331 Redirect examination by Mr. Fred Farrar:

Line of demarcation between the Poudre Valley proper and the adjacent valley of the Thompson near the Platte River, to which both streams are tributary, is not very clearly defined. Areas from which each factory draws its beets are usually those immediately surrounding that factory.

A very small percentage of the beets utilized at the Greeley, Windsor and Fort Collins factories would come from territory without the actual drainage area of the Cache la Poudre Valley or land irrigated by water from that stream.

I do not have the beets grown at Wheatland, Wyoming, separated. Another official of my company will give that if you desire it.

A large per cent. of the labor employed at the factories themselves would be common labor. Am rather doubtful of classing it as skilled labor. It is what you would better term experienced labor in that certain line of business; I suppose it would be classed skilled labor. In some instances the labor is highly technical and commands a very good salary.

3333 Redirect examination by Mr. Delph E. Carpenter:

There is no question but that, if the industry continues to exist, we will come nearer to the ideal in obtaining the scientific and theoretical feeding value, not only of beet tops but of all by-products.

The lime cake, although not at present utilized, brings $1 per ton where utilized. It is used to recover seeped or soured lands. About only communities using it are in Michigan.

WALLIS LINK, recalled.

Direct examination by Mr. Fred Farrar:

First went into Laramie River country in Colorado in 1874. First made residence there in 1890. Between 1874 and 1890 was familiar with Laramie River Country in Colorado. Observed development of ditches in that section. From 1881 I was up through the country more frequently than I was prior to that time. Did not observe ditches prior to that time, any more than knowing people
3334 had settled there prior to that date. Resided in that country about eleven years.

This was prior to time I projected this system concerning which I have previously testified to.

Am acquainted with ditch known as Long Park No. 2 diverting water from Laramie River in Colorado. Charles Shipp constructed that ditch in 1902 about middle of summer.

Link Ditches Nos. 1 and 2 were constructed by me. Date of construction of Link Ditch No. 1 was about 1894. Link Ditch No. 2 was constructed in 1896.

The Hills Ditch was constructed by J. J. Hills who used to live in Laramie. Was constructed in about 1880. He became interested in

that country about same time Yelton first went in there. The date I have given is approximately correct.

3335 Am familiar with Yelton Ditch. It was constructed about 1880, between 1880 and 1882.

Familiar with Upper Smith-Brown Ditch. It was constructed about 1879. It is sometimes called the Upper Hills Ditch.

Familiar with Lower Smith-Brown Ditch. Constructed about 1880 or 1881.

Familiar with Comet Ditch. Constructed about 1895 by the Stewarts, or a man by the name of Slack who lived there prior to the Stewarts may have constructed it.

Familiar with Homestead Ditch. Constructed in about 1884.

Familiar with Mansfield Ditch No. 1, constructed in about 1882.

Familiar with Mansfield No. 2 Ditch constructed about 1880, according to decrees, but think it was a good deal older. Believe it was constructed in about 1878, from fact that Mr. Mansfield went up and settled that country in 1874 and I know those meadows will not grow hay for several years after reclamation begins. Mansfield No.

3336 1 Ditch is later than Mansfield No. 2 Ditch. In the tabulation given by Mr. Whiting, a witness for Wyoming, Mansfield No. 2 Ditch is an earlier one than Mansfield No. 1.

Familiar with Bliler and Boswell Ditch. Think those ditches were constructed prior to 1880.

Familiar with Warren Ditch. It was constructed pretty near the same time as Bliler and Boswell Ditch. Bliler is surname of Warren. Warren in fact is the first name of Mr. Bliler. Warren Bliler was his name. He used his last name in one instance and his first name in another.

Familiar with Stuck Creek Ditch. It was constructed in 1881.

All of these ditches which I have mentioned divert water from the Laramie River in Colorado or the tributaries of that stream within that state.

WALLIS LINK.

Cross-examination by Mr. John D. Clark:

3336 I moved into the upper Laramie Valley in 1891 or in 1892, when I was about 30 years old. In 1874 I had been there on

3337 the roundup and in 1882 I worked for a ranchman in that country. My acquaintance with the ditches in the upper Laramie Valley dated from the time I moved there, and at

3338 that time so far as I know, there had been on extensions or enlargements of the older ditches. Since that time nearly all of them have been enlarged and extended as the sage brush has been cleared off and the hay land developed. The ditches extend from 100 feet to a half a mile from the river, depending on the condi-

3339 tions. Irrigation commences from the first to the 15th of May, and the water is turned off between the 7th and 20th of July, the season lasting from six to eight weeks. Sometimes after that period they will permit water to run on to a piece of land from

which the sage brush has just been cleared, but it does not do much good excepting to kill sage brush which has not been taken off.

There is a water commissioner who regulates the headgates.

3340 My Link Ditch No. 1, with 190 acres under it, had an adjudicated priority of 14 second feet, and some of the other ditches used a great deal more water in proportion to the number of acres. In cases where the land has contained a large amount of boulders which have been caused to sink by placing water on the land, they have been grassed over. My No. 2 ditch irrigated

3341 about 50 acres, and I used three second feet of water through it. After two or three weeks of irrigation, a surface run-off from the meadows back to the river was noticeable. The ditches now constructed cover substantially the whole of the upper Laramie Valley.

3342 Redirect examination by Mr. Fred Farrar:

An altogether different method of irrigation prevails under these ditches, concerning which I have testified to, than prevails in Poudre Valley. Cultivated soil would not stand the current or volume of water they throw onto the meadows in Laramie Valley for irrigation. The meadows are very close woven grass sod which protects the soil. If it were not so it would probably wash away. They irrigate very plentifully using great quantities of water.

They use the same methods down in the hay meadows on the Laramie Plains.

3343 Redirect examination by Mr. Delph E. Carpenter:

Little Laramie River drains Centennial Valley in Wyoming. A number of smaller streams flow into the Little Laramie River up in the Centennial Valley.

Centennial Valley in Wyoming compares just about the same from standpoint of use of water, as Big Laramie Valley in Colorado. Same method of irrigation prevails. There are three forks of the stream, North, Middle and South Forks which come together and it is principally meadow land between those forks, extending from one to another. Further down on north side of stream and east of where North Fork forms junction with main stream, there are some hay meadows. All of this territory of which I am speaking is above what they call Filmore.

Same characteristics of rapidity of return of water would apply to Little Laramie Valley above Filmore as prevail in Big Laramie Valley above Woods Landing. In comparison to width of meadows water would return as rapidly and in some cases more rapidly.

3344 There is the same general character of country on these two streams above these two points. They are similar. In fact nearly all of native hay lands in all these different sections up there are under same methods and characteristics of soil are similar.

Little Laramie River Valley below Filmore is irrigated by nearly same method as that prevailing on ranches above Filmore. There is a little more soil below Filmore, considerably more, in some places there is very good land along Little Laramie River.

It is customary to turn off water on these lower meadows before cutting hay, two or three weeks prior to mowing. The same is true of meadows in the Big Laramie River Valley in the Laramie Plains.

In examination some weeks since of agricultural conditions on Laramie Plains now as compared with seventies, I made a general statement. This I desire to make more clear at this time. Of course they have made an effort towards agriculture in that country on the uplands, outside of river bottoms. In some instances they have a fair crop but generally speaking, I would consider it a failure. I would consider that the attempt at raising agricultural crops in that area is a failure. They may get a good crop once in a while, but a man could not figure on that for a livelihood, because it is too uncertain.

3345 Water which has been diverted out of the Laramie River by the canals, as in case of the Pioneer Canal, has been applied to the plains, to prairie country, and nearly every depression there on the Laramie Plains at the present time, near those canals, is partially filled with water. In fact there is a general tendency to form lakes.

Not very many of those lakes had water in them prior to the construction of the Pioneer Canal. Soda Lakes were natural lakes. There is a sort of a water course that runs in a southeasterly direction from the Soda Lakes, there is a depression in there which had water in it at times, but there are a great many smaller lakes there now that were not there before the Pioneer Canal was built.

3346 Redirect examination by Mr. Delph E. Carpenter:

I have been along the ditches a number of different places and I never have seen any particular overflow, yet at some places where the hill is a little steeper than at others and the lay of the soil, which would be of a little tighter formation, the water would not percolate through it and there the water has come to the top, but if that had been an overflow it would have shown signs ne[illegible] the ditch of an overflow. The ditch is quite a considerable elev[illegible]on above these depressions. I have never seen water running directly over the surface of the ground, I have seen it where it leaks out of banks of ditch and runs into the depressions. That is what we generally call seepage.

There is no outlet to any of these ponds that I know of.

3347 Redirect examination by Mr. Delph E. Carpenter:

This little ditch out of Seven Mile Lakes is not the class of ditch you usually find in a country where lakes are drained and water is used for irrigation. I would not call it a drain ditch, not such as we have here. The contour of the country below, until you get at a considerable distance from those lakes, is higher than it is at the lake or the lake would not be there. The ditches I have seen there are surface shallow ditches. I have never seen a deep ditch there. A new road going to Woods Landing has got quite a fill and there is an outlet through for a portion of the water. I believe if the lake was not at a certain depth that the water would run out through that,

but it would not drain it. It amounts more to an overflow way
3348 than to a drainage. It is not a drainage ditch at all. Sort of an overflow or what we might call a spillway here, that is what I would term it. It has been a good many years since I was out there to see those lakes. There are three natural lakes there. The others are formed from irrigation water being used that runs through the Pioneer Canal.

LOUIS G. CARPENTER, recalled.

Direct examination by Mr. Fred Farrar:

My work has to quite an extent led me into rather a definite knowledge of various legal systems among different arid states providing the method of making appropriations and of adjudicating water rights. Discussing the Wyoming method, under laws of that state, and comparing it with the method which prevails in Colorado under the laws of that state, and considering the question from both a practical and legal standpoint I will state:—In Colorado, whose custom runs back to the earliest settlement, the right has been initiated by use, and so has had a special definition in law, that is the commencement of construction.

3349 In Wyoming, however, the right has been initiated by an application for a permit to a state officer and the granting of a permit by him.

The provisions, then, of the Colorado law, have been provisions indicating how a person, who made an application, should prove the fact, while that of Wyoming and those who have followed that system, has seemed to depend upon the prior permit.

In the development of the Colorado law, the practice has obtained of making a filing, as it was called, in the office of the State Engineer, at the present time,—earlier in the office of the County Clerk,—but all for the same purpose of giving the public notice of the fact of the intention and the filing as so made. The filing of the notice was simply preliminary statement. It might be considered to some extent as analogous to the filing on public land as a homestead. This did not give any definite right, but was treated by law and the courts as being a prima facie statement. Afterwards, the court having jurisdiction, took evidence on these various diversions of water and as a conclusion they then found a decree in which they stated the respective dates of the different ditches. The dates of each individual ditch, the amount of water to which they were entitled and this then became what we speak of as a decree. The filing was simply a preliminary statement and, as I stated, had a position not very clearly defined, but whatever it was, when the Court found its decree, the filings were entirely merged into the decree and then became simply steps, possibly, to the final decree.

3350 Beneficial use has always been the one essential under the law of Colorado, upon which appropriation of water is based. It is so under the constitution, but was always recognized prior to the constitution and was statement of an existing custom and not the initiation of a new law.

In Wyoming a permit was necessary from the State Engineer, an application was made for a permit. It is still necessary. This permit is made the beginning of their right and the State Engineer had authority to make certain conditions to these permits, fixing the time within which they were to be used and very often other conditions. At some subsequent time the individual who acquired the permit, proved up or submitted proof of his having complied with the conditions of the permit.

State of Engineer of Wyoming can refuse to grant a permit on application, under certain conditions. As I understand, he has the right, in his discretion to state whether or not there is sufficient unappropriated water in the stream for the project covered by the application. I think he has very frequently done so and he has had quite a wide discretion I believe in the matter. Under the Wyoming system, the final proof was submitted to the Board of Control an efficient board consisting of the State Engineer as chairman and of various superintendents, and their finding in the matter was equivalent to the Colorado decree.

Under the Colorado method the hearings are in court and
3351 all those affected have an opportunity to be heard. I do not understand that such is the case with the final decrees that are given in Wyoming subsequent to the early ones which included the whole stream, that is where they have given the findings for individual ditches. In fact, it has been complained of in the official reports of the State Engineer at different times, that this was one of the defects of their system, that the adverse user had no opportunity to be present and to present evidence contrary to the claims of the interested user. I do not understand that notice is given but I am not quite familiar on that detail. Where there has been a general adjudication at the beginning, that is the first adjudication on the stream, where a great many ditches come in, then a notice is posted and there is an opportunity to be heard, but subsequent to that time an individual ditch may prove up at any time and without reference to anybody else, an isolated case. An appeal lies from Board of Control to District Court in Wyoming.

Main difference between the two systems would then be, that in Wyoming a prerequisite to institution of a right is the granting of a permit from the State Engineer, which is discretionary with him, and that he and his superintendents sitting as a quasi-judicial body, later adjudicate the water rights and grants the decrees. In Colorado the filing is an incident to the essential, which is the application of water to a beneficial use. The right or decree when finally entered, dates back to the inception of the work, which was the beginning of the survey, assuming that the work is prosecuted with diligence from that date. Our statute has indicated the survey as the beginning of the work.

The decree is entered in Colorado by a district court which is a court of general jurisdiction.

State Engineer of Colorado does not have the judicial or quasi-judicial powers which are vested in State Engineer of Wyoming.

In Colorado the findings of the court are a declaration of facts and

do not depend upon the judgment or whim, you might call it, of an officer not giving a permit. Of course I do not mean to say that the official in Wyoming has ever subjected anybody to his personal whims, I don't know that he has, but it is not far different from what I have found was the practice in British Columbia, where no citizen really had any right to go on any public domain anywhere, unless the government gave him a right so to do, that he was a trespasser without a permit.

In Colorado the appropriator can construct his ditch and make his appropriation regardless of any permission having been given by the official.

I have made a critical examination of the decree of the district court of Wyoming, sitting at Cheyenne, which has heretofore been offered in evidence by plaintiffs in this case, and marked Exhibit N. I have compared it with the decree of the Board of Control, from which an appeal was taken.

3353 In Wyoming, the water is adjudicated to the lands specifically. It is an appurtenant to a particular tract. The decree so indicates in almost all cases.

In Colorado that is not the practice. In that state a ditch is given a decree for so much water.

I checked the Wyoming decree, shown by Exhibit N, in order to ascertain whether or not same pieces of land were given adjudications under more than one ditch, in other words, whether or not the decree duplicates or triplicates as to any particular land. I checked the two decrees in order to compare the lands in both and, in so doing, it developed that there were quite a good many tracts of land that were counted two or three times. I did not anticipate that in the beginning, but it did develop and I have the records of those.

There are 5,720 acres that are duplicated and an additional 615 acres that has been counted a third time, making a total of 6,339 acres in excess. This is all in the Big Laramie Valley. I think all of it is under the Pioneer Canal. This duplication arises by decreeing land to Pioneer Canal and also decreeing it to some other ditch and in some cases to two other ditches.

Duplications and triplications occur in detail as follows: In Section 20, Tp. 16 N., R. 73 W. there is in the last decree, that is court decree of 1912, 603 acres that are decreed and in addition to that in the same section there are 260 acres which would therefore

3354 be a duplication or practically so. This last area of 280 acres is in the various sub-divisions of the east half of that section. The 603 acres is decreed to Pioneer Canal Company and the 280 acres to the Bamforth Ditch. In Tp. 17 N., R. 73 W., Sec. 32, there is also a duplication in the S. W. ¼ and the N. W. ¼. There are 320 acres in those two quarters decreed to Pioneer Canal and at same time 79 acres to Fisher High Water Ditch. Inasmuch as those two quarters have only 320 acres, there is manifestly a duplication, or in other words, water is decreed to same land twice. In Tp. 15 N., R. 74 W. there are several duplications. In Sec. 12 there are 656 acres decreed to Pioneer Canal Company and also 32 acres under Cole Brothers' Ditch is decreed at same time. I do not find many cases

where Wyoming sections, according to decrees, contain 656 acres or in excess of 640 acres. On north and west of the township sections would not likely under United States measurements contain more than 640 acres. Likewise I might, in passing, speak of Sec. 14 as not being quite certain whether there is a duplication, but there appears to be because a part of that section is decreed both to Pioneer Canal and to The Laramie Suburban Homes Company. It appears that the same portion is thus decreed, but I am not absolutely sure of that fact in that section. The next case in that Township is Sec. 23, wherein the S. E. ¼ of the N. W. ¼ the Pioneer Canal has 40 acres and the Laramie Suburban Homes Company is decreed
3355 20 acres. As the area is only 40 acres there is a duplication. In the N. W. ¼ of the N. E. ¼ of the same section the Pioneer Company has 40 acres and the Laramie Suburban Homes Company is decreed 15 acres, which is therefore another case where water is decreed twice or the land is counted under two places under two ditches. In the N. E. ¼ of the S. W. ¼ of the same section, 40 acres is decreed to the Pioneer Canal and 30 acres to the Laramie Suburban Homes Company, which is again a case where the land is counted twice in the statement of the decrees. Again in same township in Sec. 30, there is 636 acres decreed to Pioneer Canal and 560 acres decreed to Last Chance Ditch. Another case where same land has received two decrees. In Sec. 32 in same township, W. ½ N. E. ¼ 80 acres is decreed to Pioneer Canal Company and same decree gives to the Laramie Suburban Homes Company 18 acres in S. W. ¼ of N. E. ¼, which is included in section of land under Pioneer Canal decree and therefore there is a duplication. It is a case where same land is given water under two different headings. In Tp. 17, N., R. 74 W. there are several cases where land has been counted 3 times. This occurs in Sec. 2. In this township, the S. W. ¼ of Sec. 1 is decreed twice. My memorandum of the owners to whom these decrees were given is not at hand. In S. ½ of Sec. 2, 320 acres, the S. E. ¼ or 160 acres and the S. W. ¼ of the S. W. ¼, 35 acres, are counted twice, both in the court decree and in the finding of the Board of Control, once to the Haley Live Stock and Trading Company in the Abbott Water Ditch and once to the Estate of Marcus W. Towne in the Abbott and Coleman Ditch. The
3356 N. ½ of the S. W. ¼, 80 acres, is decreed three times in each decree. Once to the estate of Marcus W. Towne in the Abbott and Coleman Ditch, and twice it is counted for the Haley Live Stock and Trading Company in the Abbott Water Ditch. In Tp. 18 N., R. 74 W. Sec. 22, S. E. ¼ of the N. E. ¼, 40 acres have been counted twice. In Tp. 19 N., R. 74 W., Sec. 28, the S. E. ¼ of the N. E. ¼, 40 acres, has been decreed water twice. In Tp. 14 N., R. 75 W., Sec. 70, has 640 acres decreed to Fischer Ditch and same decree also decrees 32 acres to Pioneer Ditch. In Sec. 8 of same township, Fischer Ditch is also given 200 acres and at same time Pioneer Canal is given in same section 640 acres, which as a section only included 640 acres, therefore includes 200 acres in excess and indicates 200 has been counted twice in same decree and given water. In Sec. 9 of same township, 640 acres is counted twice, once to Fischer Ditch

and also decreed at same time to Pioneer Ditch, thus indicating a duplication. Likewise in same township, whole of Sec. 17 has been given water once to Fischer Ditch for 640 acres and once to Pioneer Canal for 640 acres. In Tp. 15 N., R. 75 W., there is also a duplication in Sec. 36. In this case whole section is decreed to the Pioneer Canal Company 640 acres, while besides that, the Last Chance Ditch is given a decree for 115 acres, showing that land has been counted twice. In Tp. 13, N., R. 76 W., Sec. 3, the N. ½ of the N. W. ¼ 80 acres is decreed twice to two different ditches. In Tp. 14, N.,
3357 R. 76 W., Sec. 2 has been decreed 641 acres to Pioneer Canal and 480 acres to enlargement of Parker Ditch, and 160 acres to Parker Ditch, showing whole section has been counted twice in making up decrees. In Sec. 3 of same Tp. there are 45 acres given in N. W. ¼ to Hammond South Ditch and besides that the decree gives 641 acres to Pioneer Canal, showing that at least 45 acres has been counted under both ditches. In Sec. 10, of same Tp., there are 460 acres which includes all of the W. ½ of that section, the S. E. ¼ and the N. W. ¼ of the S. E. ¼. 20 acres of N. E. ¼ of N. E. ¼ which is decreed to the Parker Ditch and to enlargement of Parker Ditch, but notwithstanding that the Pioneer Canal Company has received a decree for 640 acres for same section, showing then a duplication for the corresponding amount. I might say that in most of these cases the duplication of land which is duplicated, was included in decree of the Board of Control while that to the Pioneer Canal Company appears in the last decree as original land. In Sec. 12 of same Tp., there are 400 acres decreed to Last Chance Ditch, this includes all of E. ½ of the section and also the E. ½ of S. W. ¼; but notwithstanding that, the Pioneer Canal received a decree for the whole section or 640 acres. In Sec. 14 of same Tp., the N. ½ of the section was decreed to the enlargement of Parker Ditch, 320 acres, but the decree also gives 640 acres to Pioneer Canal Company or in other words, decrees for whole section including land previously decreed to enlargement of Parker Ditch.

That includes the duplications in the Laramie Plains and it may be that the first summation I gave may be found to be slightly incorrect. The summation is intended to be a summation of
3358 those figures I have given. The discordance will be slight, if any. It will be from fact that in checking them up hurriedly, I suspect some of those may be omitted. Outside of those on Laramie Plains, there was only one case of duplication noticed. That was in Sec. 2 of Tp. 23 N., R. 68 W., which is in the Wheatland country.

Direct examination by Mr. Delph E. Carpenter:

They have never fixed a definition for water rights in Wyoming, so far as I know, and I think one of State Engineers complained that they have never defined it legally. I think that complaint occurs in report for 1908 at Page 73, of State Engineer of Wyoming.

I spoke of no particular method being provided for appropriator to be heard at time of fixing decree. That statement is confirmed in Ninth Report of State Engineer of Wyoming, Page 69. Water

Superintendent of Division 74 includes in his report a recommendation that some method be provided by statute so that holders of older permits could contest if they desire. That is in case where a permit is claiming a larger appropriation than the others think it is entitled to.

In the cases to which I have referred in detail they have recognized different claims.

3359 Under the Pioneer Canal, judging from the country as I know it, it is certainly correct that all decreed land has not been irrigated and also that the decrees would indicate that all of the lands have been included, that is, all of the land beneath the canal has been granted a decree whether it has been irrigated or not.

The State Engineer of Wyoming complained of that fact in the Ninth Report of the State Engineer on page 80, the State Engineer states, "Adjudications have been made and water rights granted where irrigation works have never been completed to reclaim an acre of land." Then that has occurred even in Wyoming, apparently. It has been hinted at by other officers. And there is also quite a statement to a similar effect by Mr. Mead who was State Engineer. In State Engineer's Report for 1891-92 which is first report after Wyoming became a state, by Elwood Mead, he speaks on Page 77 about trouble that has been experienced in trying to apportion waters of Crow and Horse Creeks under existing decrees and goes on as follows:—"Which appear to have no particular basis for the amounts decreed, except that each claimant was allowed all that he claimed, regardless of what effect it might have on other rights."

The same system has prevailed under the permit system in recent years, judging from the duplication in decrees which I have already mentioned. It show sto some extent in the decrees themselves, but I have heard more of it from the officers in other cases. It was somewhat to my surprise, because it had been stated, that such things were not to be found under the Wyoming system. As I understand, it is a fact that state officials of Wyoming have claimed credit in times past for originating the permit system and have claimed that that was the only perfect system known. With increased knowledge and experience, they have found that the assumption was erroneous.

The fact that ditches very frequently appear in Wyoming, where land is apparently still arid and not kept in state of irrigation, has been explained and I have seen some statements in print, attempting to explain that fact. These statements go back largely to time when there was some contest between stock growers and incoming settlers, as a specific case, in the Irrigation Age, Volume 3, Page 91, which was about the time of the so-called stockmen's war in Wyoming, it was stated, and I believe on the statement by a Wyoming citizen, that land had been taken and ditches built to get title to land and for purpose of keeping out the small settlers who might interfere with occupying the land for stock purposes.

State Engineer of Wyoming, under permit system, is authorized to decline a permit in cases where he thinks there is not unappropriated water in the stream.

Where a permit is granted in Wyoming, it is in effect, a declara-

939

tion by the State Engineer that there is water in the stream for appropriation.

3361 It has been found that even in such cases, however, his judgment was too conservative. I think it has been mentioned in some of their reports also that they found such cases. Of course, that is really an illustration partly of the fact I mentioned in my direct examination sometime ago, that water might have a greater use than they anticipated. So that, there have been cases where they have found there was a great deal more water than they have anticipated. Of course a part of that, I presume, is due to the general tendency of people in office to take what they think is a safe view and thus make an estimate or decision that at any rate would be on the safe side. It has even been true on the Laramie and was found that the water they could divert was a great deal more than they had anticipated.

The fact that some areas of land in Wyoming are limited to production of crops of limited value, such as native hay, is asserted in State Engineer's reports for that state. In first State Engineer's report, first volume, report for 1891-'2 by Elwood Mead, he speaks of fact that best results can be obtained only by union of irrigable and pasture lands and that to attempt to cultivate such lands to grow grains or vegetables for market, as is done in valleys surrounding Salt Lake or Denver, and as can be done with irrigable lands along the Platte, Green and Big Horn Rivers, is out of question. This appears on page 34 of the first Engineer's report.

He states as follows on same page:—"Many are of an elevation which restricts production to the hardier crops and all are limited to the growth of those which can be profitably consumed at home."

That same observation applies to Laramie Plains region.

3362 Value of water when used on lands capable of producing heavier crops as compared with use of water on lands used for production of native grasses, has been noted by State Engineer of Wyoming. In Fifth Biennial Report of State Engineer of Wyoming, 1899-1900, at Page 52, the State Engineer states as follows:—"The water supply of the creek is almost entirely employed in irrigating cultivated lands, it being of too great value to be used on native grasses." Thus recognizing that the value for grasses is subordinate to its value for crops. In this case, the creek in question was Owl Creek, in northern part of state at a relatively low elevation, one of lowest parts of the state.

"Best development" under irrigation was declared by State Engineer Johnson of Wyoming in the Ninth Biennial Report at Page 80 as follows:—"By the 'best development' we must always understand, that growth and progress which leads to the support of, and the service to the greatest number of people." That would seem to be a consequence of the doctrine that lands capable of producing heavier and more valuable crops under irrigation are to be given the preference over lands used for the production of native grasses under irrigation.

L. G. CARPENTER.

Cross-examination by Mr. N. E. Corthell:

3362 My knowledge of the legal methods of the system of irri-
gation procedure in Wyoming is not gained from participa-
3363 tion in these proceedings nor from practice in irrigation
matters in that state, but from the reports of the state engi-
neers and conversations with officials and a general observation of
these matters. I do not know to what extent the doctrines of the
state engineers I have referred to have been sustained or have been
rejected by the Wyoming courts, but in one instance I believe the
courts rejected one of the theories.

Cross-examination by Mr. John D. Clark:

3364 I do not know that in 1901 the Wyoming statute regulat-
ing adjudication proceedings provided for notice as in an
original general adjudication when proof is taken upon subsequent
appropriations. The state engineer's report in 1908 contained a
complaint based upon the non-existence of any such statute.
3365 In Colorado the commencement of the survey of a ditch is
the initiation of a water right, which must be followed by
actual construction work within a reasonable time as determined
by the adjudicating court, and the work must be prosecuted with
diligence. Formerly the application of water to beneficial use
3366 was not requisite to the completion of the right, but in more
recent years some district courts have required the beneficial
use as a condition to the perfection of the right, and some have not,
the Supreme Court not having had the matter before it, but until
the court has rendered a decree, neither the appropriator nor any
third person can be positive whether diligence has been used or not,
nor whether the adjudicating court will find that there has
3367 been diligence exercised. The adjudication proceedings in
Colorado are voluntary, and until the appropriator sees fit
to go into court and apply for an adjudication there is no public
record which fixes the time of his commencement of work, although
he must now file his map and claim within sixty days after begin-
ning work. The courts disagree as to whether the filing of this
map and claim is essential to the acquisition of the water
3368 right. Under the Wyoming Irrigation Code, a water right
may be acquired only upon the granting of a permit which
fixes the filing of the application, which fixes definitely the date of
priority if the permit is complied with. The state engineer is re-
quired, in approving an application for a permit, to embody in his
approval the statement definitely limiting the applicant to a certain
time within which to complete the construction work, and a definite
time within which to complete the application of water to a
beneficial use, which may not be more than five years, although the
time may be extended by the state engineer. The permit is a public
record, and its terms are open to inspection by the public, and I
never had any difficulty in examining such permits. Under these

conditions a Wyoming appropriator knows in advance how rapidly he must prosecute the work, how long he has for its completion, and the time within which the water must be applied to beneficial use, and any third person has the same information, so that
3369 the only undetermined matter is whether the work has been performed in accordance with the permit. If work has been performed in accordance with the permit, there can be no uncertainty as to whether diligence has been exercised by the appropriators.

3369 Redirect examination by Mr. Delph E. Carpenter:

Appropriators in Colorado must appear, according to the Statutes, at what is called a general adjudication or be forever barred within two or four years, as the case may be, after the entering of the decree. In speaking of his appearance at such adjudication proceedings as a voluntary act, I had in mind by that that there was no definite time in which he must make application. The application by anyone, however, may force all the others in, but the time at which that application is made is subject to their will and desire.

3370 The granting of extension of time under the Wyoming system by the State Engineer from time to time, is permissible. The State Engineer has the option of doing that. I suppose different things may bear upon his judgment or inclination. If diligence has been exercised, that would undoubtedly be taken into account. In Wyoming, the permission merely amounts to a supervision of the construction from the time of the initiation up to the decree.

Failure of parties to have opportunity to appear and contest claims for their water rights in Wyoming is noted in the Ninth Report of the State Engineer of Wyoming, Mr. Clarence T. Johnston, State Engineer, in which he embodied a report from Mr. Walter B. Dunton, Superintendent of Water Division No. 4, and particularly to matters appearing on page 69 of the official report of the State Engineer.

On Page 69, he states: "There are at present no laws providing for a method of contesting proofs made under permit. This should be remedied, and some similar method provided for such contests as are now provided for contesting proofs made upon original adjudication of the stream. It frequently occurs that an appropriator who has recently taken out a permit for a water right from some stream, is interested in the right to be granted the holder of some prior permit from that stream. He is certainly entitled to be heard if he believes that the prior holder, by his proof upon that permit, is claiming a larger appropriation than he is lawfully entitled to, and some method should be provided by statute for notifying the holder of the later permit, and giving him an opportunity to contest if he so desires, and if he does not contest after such notice, for making the determination of the prior holder's right, binding upon him." That is the matter to which I refer.

3371 Redirect examination by Mr. Fred Farrar:

I do not presume to testify to the intricate details of court decisions affecting laws of state of Wyoming but only testify generally. Same is true of laws of Colorado, except I am naturally better acquainted with details here than I am in Wyoming.

L. G. CARPENTER.

Cross-examination by Mr. John D. Clark:

3371 In the early history of irrigation in Colorado, the courts based their decrees upon the capacity of the ditches
3372 without taking into consideration the amount of water applied upon the land. The appropriators engaged in adjudication proceedings were also more interested in their own claims than in those of the other claimants, and as a result, the courts were overgenerous in their decrees and excessive appropriations were frequently allowed. This is not true of the later adjudications.
3373 I have had occasion to examine some of the decrees of the Wyoming Board of Control, and I do not believe there is much difference between the accuracy of those decrees in uncontested proceedings and the early decrees of the Colorado courts.

3373 Redirect examination by Mr. Delph E. Carpenter:

In the Eighth Biennial Report of the State Engineer of Wyoming for years 1905-6, Clarence T. Johnston, State Engineer, Mr. Walter B. Dunton, Superintendent of Water Division No. 4, in his published report at pages 76 to 80 inclusive and particularly on page 79, calls attention to necessity of providing means of contesting these proofs of permits same as he does in the Ninth Report for 1907-8. It is to same effect but a somewhat briefer statement.
3374 Preliminary filings made in Colorado by various claimants appearing in adjudication proceedings, at least in times past, were seldom used in the final proof before the court in adjudication proceedings or in proceedings for decretal orders of any kind in those proceedings. As indicated in answer to an earlier question, some district courts have rather different practices from others and some courts call for these filings as necessary step before they enter into an adjudication, but that has not been general practice.

Rights of appropriators are protected in Colorado in general adjudication proceedings, even though no statement of claim has ever been filed.

3375 C. P. LINK.

Direct examination by Mr. Charles F. Tew:

Reside at Denver. Previously resided in Park County, Colorado. Have had experience in determining, assessing and fixing values for taxing purposes. First experience was in Park County, Colo., in 1892. Was appointed deputy assessor in that county and for fol-

lowing six years acted as deputy assessor and deputy treasurer. In fall 1899 was elected county assessor and served for 9 years, during which time was member of state board of thirteen assessors. 1901 and following years, served on practically every state committee of assessors. May, 1912, was appointed a member of the state tax commission and am now serving as member of that body.

While acting in capacities mentioned in Park County, it
3376 was my duty to consider valuation of property. When member of state committee of thirteen assessors, was elected by body of assessors of state, all assessors of state met in convention and chose thirteen. At that time it was our duty to assess all inter-county corporate property of state. Did not have duty of fixing equalization between counties. Have attended various conventions of assessors. These conventions were annually held for purpose of comparing assessments of several counties of state and arriving at equal valuation of all classes of property. End being to have all taxes in different counties as nearly equal as possible.

In discharge of my duties in these several services, became acquainted with property values in several counties throughout Colorado. Made quite extensive study of those values.

Prior to creation of tax commission, general practice was to assess at one-third value. Since tax commission law has
3377 been passed and the commission came into being, we have attempted to follow the law strictly and assess at full cash valuation. Since my appointment upon tax commission, have not engaged in any other business. Tax commission consists of three members, a working force, consisting of secretary, assistant secretary, clerk and stenographer, and at times we are given special men to secure data and information in the counties.

Duties of state tax commission are to act as supervisors of assessment and collection of general property taxes in state and also to assess utility corporations in the state. It has duty of fixing assessment upon all public utilities, including railroads, telephone, telegraph, street railway, electric light, gas, water and all other utility corporations and all corporations having business in two or more counties. Commission also has complete supervision over assessors.

There are 63 counties in state. One of objects and duties of commission is to obtain equal burden of taxation upon the property assessed by the assessors of these 63 counties.

3378 Steps taken by commission to obtain information in regard to property valuations throughout several counties are as follows:—First, we have conferred and labored diligently with all assessors; we have gathered all information possible from every source that reflects values of both real estate and personal property in various counties through actual conveyance, record conveyance, of property, properly verified by getting facts from either grantor or grantee or agents connected with conveyance of property; also by comparing loans made by individuals and regular loan and mortgage companies; securing value of water rights where it was possible so to do; gaining extensive information from census enumeration

made in 1910 which was considered one of best sources; talking with actual owners and assessors of various classes of property in counties; securing state records that are officially taken from inheritance tax and any other miscellaneous information that would tend to add to our sources.

We have gathered data personally and by agents in every possible way, to ascertain value of property throughout several counties of Colorado. In this way we have gained and do now possess knowledge of those values. In discharge of these duties, I have made personal inspection and visits to different localities and sections for purposes described. Have made observations and gathered information as to returned valuations of property subject to assessments. We have generally gone over state, and counties not reached personally we have reached by our official appointees.

Am acquainted with territory extending over counties of Larimer and Weld in northern part of state known as the Cache la Poudre Valley. Have made visits to that territory since my appointment on the tax commission. Have had reports from that territory as to sale prices of land. Have made inspections of records as to sale prices and stock values. Have obtained crop reports and data. Have compared report of census bureau for census of 1910, in my study of these values, with report made by assessors in the
3380 Poudre Valley in these counties and elsewhere throughout the state. The census enumeration gives a higher value and more property than found by assessors.

In my duties in equalization, have had my special attention brought to consideration of values in counties of Weld and Larimer. Our investigation has been more scrutinizing and close in those counties than in others throughout state.

Cache la Poudre Valley is very highest valued section of Larimer and Weld Counties. Exclusive of small sections of fruit land, it is highest valued farm property in Colorado.

Weld County has highest value of any farming property in state. The City and County of Denver, only, has higher valuation than County of Weld. It is not a farming value. In farming communities, Weld has the highest value and Larimer has the second. In wealth all told, Weld County is second in valuation.

3381 Major portion of assessed valuation of Weld County lies under ditches. I should think practically 90% of valuation of Weld County lands lie under ditches. The main wealth lies within ditch sections of the county.

The fact also pertains to Larimer County.

$76,988,520 total assessed valuation of Weld County in 1913. That is exclusive of exempted valuation, approximately $1,500,000. These exempted valuations are exemptions allowed householders by statute, $200 to head of each household in personal property and where moneys and credits are assessed, exemptions are allowed on those.

Between $78,000,000 and $79,000,000 was total valuation, both estimated and assessed by taxing authorities of Colorado in 1913, for Weld County.

$32,503,372 total assessed valuation of Laramer County in 1913. I do not have property exempted there, it is something under $1,000,000.

305,612 acres of irrigated land in Weld County in 1913 acording to return made by county assessor. Highest values of land of that total area is within Cache la Poudre Valley. Average value per acre of this irrigated territory, which is in Weld County, is very much lower than average value per acre of that irrigated territory in that part of county known as Cache la Poudre Valley. $25,784,790, approximately, is aggregate assessed value of the 305,612 acres of irrigated land, including improvements, in Weld County.

Assessed valuation of property in Weld County is very much less than that given by census of 1910. Assessed valuation of county by census determination for 1910 was not over 15%. That was at time that values were taxed on basis of one-third value. The same ratio of difference between assessments and census returns for 1910 does not prevail for 1913. Assessors with effort of tax commission have greatly raised and increased assessed valuation for 1913
3383 over 1910. Same ratio is true as to quantity of property.

Almost uniformly assessors find much less property for assessment than that enumerated in census. That pertains to Larimer County as well.

Testimony I have given in regard to high value of real estate, irrigated land, in Cache la Poudre Valley, in Weld County, as compared with other portion of irrigated territory, pertains to Larimer County as well.

111,278 acres of irrigated land returned by abstract of assessment for Larimer County in 1913. A large part of that area was within Cache la Poudre Valley.

$10,918,000 approximately total value of irrigated land in Larimer County, 1913, including improvements.

Lands in Cache la Poudre Valley Range in value from $100 to $300 per acre, including lands, water rights and improvements. Small tracts and areas close to Greeley and other cities in Valley range in price from $400 to $1,000 per acre.

The lands in Larimer County, in the Cache la Poudre Valley, range about the same. The average, in that county, is not quite so high as in Weld County.

In Larimer County there are a number of fruit orchards in the Poudre Valley Value of those lands is very much higher than the agricultural areas I have just described. There are small tracts adjacent to Fort Collins of values similar to those I have described and reach as high as $1,000 per acre.

Cross-examination by Mr. N. E. Corthell:

Valuation I have given for assessment of Weld County for 1913 was finally determined and established October, 1913. It was made part of record of office of State Tax Commission of Colorado at that time.

3385 Redirect examination by Mr. Fred Farrar:

Value I have mentioned was not original valuation made by assessors. It was value as equalized by Colorado Tax Commission and State Board of Equalization. This is the first year in history of Colorado wherein a systematic and definite effort has been made to assess property for purpose of taxation upon full cash value. There has been some trouble and litigation incident to that change in plan. Powers of Tax Commission were at one time questioned, and until recently decided by the Supreme Court of this case.

Redirect examination by Mr. Charles F. Tew:

Acquainted with class and character of horses and mules that are used in tillage of irrigated territory in Cache la Poudre Valley. Animals are of very best farming class in state.

2,017 mules were assessed in Weld County in 1913 according to abstract of assessment. Assessed valuation was $135 per
3386 head. I think that is the fair valuation. Horses, generally speaking, employed in agricultural districts of Cache la Poudre Valley, are of class similar to mules as just described.

3387 JOHN E. FIELD, recalled.

Direct examination by Mr. Fred Farrar:

Using Plaintiff's Exhibit C, a small map showing gauging stations on Laramie River, according to R. I. Meeker, a witness for plaintiff, as a basis, I will designate where other measurements have been taken on Laramie and Poudre Rivers, which will be referred to in my testimony to follow. Gauging station on Cache la Poudre River is between junction of Cache la Poudre River proper and north fork of Cache la Poudre River and town of Fort Collins. On Plainiff's Exhibit C, north fork of Cache la Poudre River is marked "Sheep Creek." Gauging station is perhaps half way between town of Fort Collins and junction of north fork with main Poudre River. It lies just below Poudre Valley Canal. Referring to map attached to corporate Defendant's answer, approximate location is in Sec. 15, Tp. 8 N., R. 70 W., about four miles below junction of the two rivers. There is also a gauging station which will be mentioned, on McIntyre Creek at point almost due west from Glendevey gauging station on Laramie River. This gauging station is 5 or 6 miles above mouth of McIntyre Creek.

3388 Glendevey gauging station on Laramie River is indicated on Plaintiff's Exhibit C by yellow circle, being only yellow circle in State of Colorado on that Exhibit.

There is also gauging station or weather and gauging station on Laramie River about mile south of Colorado-Wyoming line. This gauging station is known as Deckers and is not shown on Plaintiff's Exhibit C, but would be immediately south of yellow circle shown, close to Colorado-Wyoming boundary line and within boundary of State of Colorado.

Upper gauging station which I have mentioned on McIntyre Creek, would be on blue line representing stream due west of yellow circle on Plaintiff's Exhibit C.

There is also a station at mouth of McIntyre Creek, which would be at junction of previously mentioned blue line and blue line representing Laramie River itself. This last mentioned station would be at Gieneyre. This last one is not shown on Plaintiff's Exhibit C.

Temporary gauging stations were established on nearly all of the tributary streams and none of these are shown on Plaintiff's Exhibit C. They were generally near mouth of tributaries or at some convenient place near mouth of these streams.

On Cache la Poudre River, two canals of considerable size, divert water above the gauging station. They are the Poudre Valley Canal and the North Poudre Canal. There are some small ditches
3389 which have not been considered in my analysis of the flow of the Poudre. The North Poudre Canal diverts its water from the north fork of the Poudre. The Poudre Valley Reservoir Company's canal diverts from main stream about 4 or 5 miles below junction of North Poudre and main stream. This Poudre Valley Canal is a part of the system of The Greeley-Poudre Irrigation District. It is indicated on map attached to Answer of corporate Defendants by a red line. Referring also to this map, there appears on the North Poudre River a reservoir designated as Halligan, at a point about 8 or 10 miles immediately south of Wyoming line. The North Poudre Irrigation Company owns that reservoir. The diversion ditch of that company leaves the stream bed 4 or 5 miles down stream from that reservoir and is indicated on map by an ordinary line. This North Poudre system irrigates land lying directly north and northeast of Fort Collins.

Referring to Sand Creek or Divide Canal and its relation to Wilson Supply Ditch, will state that Wilson Supply Ditch was constructed from Deadman Creek to carry water from that stream over into Sand Creek. This ditch is noted on the map attached to the Answer of the corporate Defendants on extreme edge of northerly part of the drainage area indicated as tributary to diversion
3390 system of the Greeley-Poudre tunnel. The water so carried from Deadman Creek into Sand Creek flows down the latter stream a short distance and is diverted into the Divide Ditch. This ditch carries water across the Divide between Sand Creek and the Cache la Poudre River and the water is discharged into a tributary of the Cache la Poudre. This system is variously described by different people. Upper portion is generally called Wilson Supply Ditch. The ditch across Divide between Sand Creek and Cache la Poudre is called the Sand Creek or Divide Ditch. Practically speaking, the Wilson Supply Ditch diverts water from upper reaches of Deadman Creek, puts that water into the upper portion of Sand Creek and Sand Creek is used as a carrier until the head of the Sand Creek or Divided Canal is reached where the water is again diverted and carried over into Sheep Creek, a tributary of the North Poudre.

Sand Creek and Deadman Creek are both tributaries of Laramie River. Deadman Creek reaches Laramie River just above Glendevey

rating station and is intercepted by East Side Collection Ditch of Greeley-Poudre system. Sand Creek flowing northeasterly does not reach Laramie River until it has passed boundaries of Colorado and into State of Wyoming some twenty miles.

Grand River Ditch is a portion of the system of The Water Supply and Storage Company and diverts water from Grand River into Cache la Poudre River.

3391 Sky Line Ditch diverts water from upper reaches of Laramie River into Poudre River and belongs to same company.

The Michigan Ditch, diverting water from Michigan River, a tributary of the North Platte, over into Cache la Poudre River, belongs to what was formerly known as Mountain Supply Company's system, but now forms part of the North-Poudre Irrigation Company's system. Latter company owns Halligan Reservoir and North Poudre Canal.

Grand River Ditch, Michigan Ditch and Sky Line Ditch have been constructed and diverting water for use for irrigation in Cache la Poudre Valley for a number of years.

Headwaters of Cache la Poudre River and Laramie River are close together, as matter of fact, smaller streams which form headwaters of those two rivers practically interlace.

One notable difference between these two streams is that Cache la Poudre River runs directly away from main range of mountains, while Laramie River runs parallel with this range for con-

3392 siderable distance. Divide between Poudre and Laramie drainages is not high and is not broad. The divide or mountain range between Laramie River and tributaries of North Platte is higher than between Poudre River and Laramie River and is more extensive.

Laramie River is fed by a number of tributaries coming in from west in general direction along this divide to west of stream.

Largest tributary of Laramie River entering stream from west is the Little Laramie, which heads in direction of range generally called Centennial Mountains in Wyoming. On other hand main tributary of Poudre River is North Poudre, which heads on east side of this lower range intervening between Poudre watershed and Laramie watershed.

Run-off of Cache la Poudre River must necessarily be considered in connection with run-off of Laramie. I made careful study of Cache la Poudre River, its flow and use of water from the stream, for reason that it is nearest developed area geographically to Laramie River area. Watersheds are somewhat similar and flow in two streams from year to year would follow each other more or less closely.

A high year in Cache la Poudre River would probably also show high run-off on Laramie River in same year, similarly, a low flow of Cache la Poudre would probably show low run-off on Laramie River.

In this case there was a necessity, to my mind, of showing run-off on Cache La Poudre River for three purposes: First, as I said, to make a comparison between flow from year to year of Cache la

Poudre and that of Laramie and to enable me to fill in missing records; also to show use of water and duty of water in Cache
3393 la Poudre Valley. It was also necessary, I thought, to show whether there was surplus of water in Cache la Poudre and, if so how much, and whether there was sufficient water remaining in Cache la Poudre River to serve the Greeley-Poudre Irrigation District or whether supply at present is insufficient to irrigate even that land which is now under ditch, outside of the Greeley-Poudre Irrigation District.

My conclusions, after examining records and studying conditions of water supply now in use, are that there is some water during flood periods which is not now utilized by the ditches in the Cache la Poudre Valley, which might be used. I am assuming of course the demand exclusive of the demand of the Greeley-Poudre Irrigation District and also disregarding the demands of ditches on South Platte River below mouth of the Cache la Poudre.

My conclusion also was that there were areas under some of ditches not now receiving sufficient water to produce best results and that there are periods during certain portions of year when there is scarcity of water and during certain years that there is shortage for entire year under some of the existing ditches. My investigations, study and observations lead me to conclude these to be the facts.

Records of flow of Cache la Poudre River extend from 1884 to 1913, a period of thirty years, which length of record should give very good idea of what average flow of stream is and what the normal condition is, while a shorter record would not be so good.

Ordinarily we assume that 20 year record can be taken with considerable reliance as indicating variations on stream.
3394 There is 1½ months record in 1881 on Poudre River but conditions concerning this year were not well known and it was at time when measurements of rivers were somewhat uncertain and shortness of record itself, being for about 1½ months, renders it without much value except possibly in aiding one in determining average run-off for month of July. Month of July was entirely covered by 1881 record. Even in this case of the July record in 1881, it was a coincidence that the normal run-off as shown by thirty years' records for month of July, is almost exactly same as that recorded for July 1881. Result is it makes no difference whether we use or discard that particular record.

I have table showing discharge of Cache la Poudre River for 30 years and this table I believe covers practically all extant records.

(Table marked Defendants' Exhibit 123.)

(Defendants' Exhibit 123 offered in evidence, table showing run-off of Cache la Poudre River at gauging station mentioned *my* witness, run-off being measured in acre feet for period commencing with 1881 and ending 1913.)

(COPY OF DEFENDANTS' EXHIBIT 123.)

State of Colorado—Engineering Department.

Discharge of Cache la Poudre at Mouth of Cañon. Drainage Area. 1.060 Square Miles.

Run-off in acre feet.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
1881.....	.....	.....	.....	.....	.....	.....	53,915	.....	.....	.....	.....	.....	.....
1884.....	.....	.....	°4,100	13,010	155,958	286,356	131,817	48,674	18,151	°12,500	.....	.....	670,566
1885.....	.....	.....	.....	°21,900	87,233	173,200	114,162	40 370	16,210	°12,400	.....	.....	465,475
1886.....	.....	.....	.....	*14,400*	80,487	111,627	44,087	20,783	11,008	°8,000	.....	.....	290,392
1887.....	.....	.....	.....	*10,300*	°90,000	°105,000	44,980	18,760	*10,300*	*7,500*	.....	.....	286,840
1888.....	.....	.....	°6,400	10,590	29,390	°64,800	24,640	13 400	6,250	°6,900	.....	.....	162,370
1889.....	9,516	6,127	3,306	6,718	47 370	79,660	31,420	11,535	4,082	4,282	5,200	3,954	213,170
1890.....	5,042	4,404	5,230	11,900	64.200	76,200	39,844	17,831	6,129	4,919	3 630	4,000	243,329
1891.....	5,655	4,225	3,606	8 545	72.839	113.048	33.298	14,005	8,216	7,285	4,959	4,834	280.515
1892.....	3,940	6,670	4,800	°6,000	°25,000	90,000	45,190	°14 100	*7,800*	*5,700*	.....	.....	209,200
1893.....	.....	.....	.....	*8,100*	°34,400	°107.600	37,730	°15,000	*8,000*	*5,900*	.....	.....	216,730
1894.....	.....	.....	.....	*11,800*	°86 444	122,760	51,390	20,820	9,780	6,450	°5,500	.....	314,944
1895.....	.....	.....	.....	*11,700*	°74,000	°140,000	67,170	30,450	°12 780	*8,400*	.....	.....	344,500
1896.....	.....	.....	.....	*5.800*	35,900	°55.000	28,140	16,700	°16,600	*4,200*	.....	.....	162.340
1897.....	.....	.....	.....	*13,700*	°126,000	°105.000	46,070	°21,700	°9,700	*9,900*	.....	.....	332,070
1898.....	.....	.....	.....	*6,700*	°40,000	°77,900	29,380	°9,720	4 790	°3,800	.....	.....	172,290
1899.....	.....	.....	.....	*15 400*	°75,000	156,610	88,590	34,250	12,640	°7,000	.....	.....	389,490
1900.....	.....	.....	.....	°46,000	172,700	175,080	44,330	16,290	8,870	°7,800	.....	.....	471,790
1901.....	.....	.....	.....	*16,700*	108,030	116,410	°49 000	20,720	9,040	°7,060	.....	.....	326,960
1902.....	.....	.....	.....	*6,000*	*37,300*	°76,000	25,271	10,514	9,878	°9,000	.....	.....	173,963
1903.....	.....	.....	.....	°13,550	47,420	161.450	°58,000	*24,300*	*12,500*	*9,100*	.....	.....	326,920
1904.....	.....	.....	.....	9,406	°75 000	°135,000	64,150	20,140	°10 460	*7,300*	.....	.....	321.456
1905.....	.....	.....	.....	18,863	63,400	161.057	55,830	20,906	9,418	°6,500	.....	.....	335.974
1906.....	.....	.....	.....	°15,000	66.574	98,290	57,500	°17,570	°11,600	°9,000	.....	.....	275 534
1907.....	.....	.....	.....	7,081	39,712	165,328	109,096	29 112	11,181	°8,000	.....	.....	369,510

Copy of Defendants' Exhibit 123—Continued.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
1908.....	.....	.....	.....	8,039	*34,000	88,839	*44,000	47,098	13,613	*8.580	.....	.....	244,169
1909.....	.....	.....	.....	14 200	43.230	220,300	113,800	28,320	19,720	8,554	.....	.....	448,124
1910.....	.....	.....	.....	*6,000*	*45,000	56,469	16,540	7 870	9,045	9.192	5.891	3,212	159,219
1911.....	2.975	2,410	2,462	4,118	50,363	101,578	46,973	13,426	10,316	7,716	3,876	2,797	249,010
1912.....	2,668	3,015	4,173	3,727	48 241	130.074	75.646	26,394	12,585	10,035	2 795	.....	319,353
1913.....	.....	.....	.....	*6,179	56,568	73,370	32,465	16,294	12,139	11,314	*5,800	.....	214,129
Total..	29,796	26,851	34,077	351,426	2,011,759	3,624,066	1 705,024	647,052	322,801	234,833	37,651	18,797	.....
Mean..	4,966	4,475	4,260	11,714	67,059	120,800	55,001	21,568	10 760	7,828	4,706	3,759	316,896

*Estimated from fractional months.
Figures underscored [italicized] estimated.

Table shows total run-off for each month of which we have record. In original records, some of months were incomplete, only parts of months being shown. I have completed by estimating record for month and these changes from original records based on these estimates are placed in the table and are indicated by asterisks
3395 or stars [*] preceeding the figure. Also, in order to obtain average run-off as closely as possible between months of April and October inclusive, I have supplied missing data, especially for month of April, in two cases for month of May, in one case for month of August, four cases for month of September and in eight cases for month of October. These estimates are shown in red on exhibit. They were made by considering flow for portion of year which was given in record, by comparing it with other years of which we had record, and comparing it with average as shown, and in some cases records on adjacent streams were considered. Out of 244 months only 27 months were so estimated. Those figures preceeded by asterisks [*] are records for month estimated upon partial record for month. Those in red are estimated in other manner which I have described, for month as a whole, they are entirely estimates.

In order to get year's record, or portion of year covered by record, you merely read right across page from left. Total for year covered by record is shown in right hand column. Extreme right hand column shows aggregate flow for months of which we have record and does not represent total flow for year.

There are from one to five missing months, in most cases in different years, in which no attempt has been made to make estimate.

At foot of page appears line indicating totals. Those are
3396 total aggregate discharges for each month during this period of 30 years as shown by records. That line marked total is really not significant. It is merely a convenience for calculating what the mean discharge for several months is. For instance, total for month of January is total for six years as shown, while total under month of June is total discharge for entire 30 years. In one case we have divided total by six to get the mean, and in the other we have divided it by thirty.

315,896 acre feet is the mean annual discharge of the Cache la Poudre River for the thirty year period, so far as we have records.

Year 1884 appears to have been one of unusually large flow, being largest in fact recorded and being first year of which record was kept. The record might be open to suspicion as being possibly in error were it not for fact that tradition has it that it was a year not only of very large flow but one which has never been equalled since. There appears to be no error in the record and there appears to be no reason for discarding it.

Table was particularly designed to ascertain, as I have stated, what was flow from April to October inclusive. Table shows that average run-off for that period was 294,730 acre feet. That is that amount of water passed gauging station. It is probable that discharge for months of November, December, January, February and March was too low for reason that with exception of years 1884, 1894 and 1912, winter records are for years considerably below

normal and even the years 1894 and 1912 are very little above normal. These five winter months, November to March inclusive, appear to give about 7% of total on table. This is probably
3397 incorrect, because winter months shown were as I stated, years of low flow, and because diversions from other water sheds into Poudre water shed, generally speaking, occurred between April and October, and therefore the summer run-off is larger in proportion to winter run-off, than it should be. It is my opinion that average run-off for months of November to March inclusive is probably more than 5,000 acre feet for each of said five months.

These records include flow brought over from other water sheds, as I have stated, and they do not include diversions above gauging station by North Poudre Canal and Poudre Valley Canal, so that, before reaching any conclusion based on these records, one must take into consideration the influence of the four inter-watershed diversions, namely, Sky Line Canal, Divide Ditch, Grand River Ditch and Michigan Ditch, and must also take into consideration amount of water diverted by Poudre Valley and North Poudre Canals above gauging station. After making due allowance for these disturbing influences, we get net run-off at cañon. Gauging station is at cañon, which would show natural run-off of Cache la Poudre uninfluenced by diversions into water shed or by water taken out above gauging station.

Result obtained represents amount of water which passes gauging station, there are no considerable tributaries below gauging station. Very little water reaches river below the station, so that this represents practically the supply of the Poudre Valley at gauging
3398 station. I will speak of lower sources of supply later.

Am able to account for water diverted through these four trans-mountain ditches and to calculate net amount at gauging station after deducting diversions of North Poudre and Poudre Valley Canals. I have prepared table which takes as its basis flow as shown on Exhibit 123 and from flow so shown I have deducted flow discharged into Poudre drainage by Sky Line Canal, Sand Creek or Divide Ditch, Grand River Ditch and Michigan Ditch and I have added amount of water which was diverted by Poudre Valley Ditch and North Poudre Canal. Result being that net run-off of Cache la Poudre River as shown by 30 years' records between month of April and month of October, including those months, is 297,322 acre feet as against an average run-off as shown on Exhibit 123 of 294,730 acre feet.

(Defendants' Exhibit 124, marked and offered in evidence.)

(COPY OF DEFENDANTS' EXHIBIT 124.)

State of Colorado—Engineering Department.

Discharge of Cache la Poudre (Net Run-off Table—Acre Feet) at Mouth of Cañon from April to October, Inclusive.

Drainage Area, 1,000 Square Miles.

	Cache la Poudre at cañon.	Skyline.	Sand Crk. Ditch.	Grand R. Ditch.	Michigan Ditch.	Poudre V. Ditch.	No. Poudre Canal.	Net run-off at cañon.	Percent of normal.
1884.....	666,466	.....	....	.....	.....	.....	.....	666 466	224
1885.....	465,475	.....	....	.....	.....	.....	.....	465,475	157
1886.....	290,392	.....	....	.....	.....	.....	.....	290,392	98
1887.....	286,840	.....	....	.....	.....	.....	.....	286,840	96
1888.....	155,970	.....	....	.....	.....	.....	.....	155,970	52
1889.....	185,067	.....	....	.....	.....	.....	.....	185,060	62
1890.....	221,023	.....	....	.....	.....	.....	.....	221,023	74
1891.....	257,236	.....	....	.....	.....	.....	.....	257,236	87
1892.....	193,790	.....	....	.....	.....	.....	.....	193 790	65
1893.....	216,730	.....	....	.....	.....	.....	.....	216,730	73
1894.....	309,444	.....	....	.....	.....	.....	.....	309,444	104
1895.....	344,500	.....	....	.....	.....	.....	.....	344,500	116
1896.....	162,340	.....	....	.....	.....	.....	.....	162,340	55
1897.....	332,070	.....	....	.....	.....	.....	.....	332,070	112
1898.....	172,290	.....	....	.....	.....	.....	.....	172,290	58
1899.....	389 490	17,699	....	.....	.....	.....	16,800	388,591	131
1900.....	471,790	18,657	....	.....	.....	.....	21,440	474,573	160
1901.....	326,960	23,805	....	.....	.....	.....	36,000	339,155	114
1902.....	173,963	22,124	1,925	.....	.....	.....	1 722	151,636	51
1903.....	326,920	26 114	1,713	1,707	.....	4,936	42,828	345,150	116
1904.....	321,456	23,434	6,810	1,975	.....	°15,000	11,200	315,437	106
1905.....	335.974	13,291	0	6,170	861	°20,000	26,000	361,652	122
1906.....	275,534	16,693	5,004	11,980	1,923	21 980	18,060	279,974	94

Copy of Defendants' Exhibit 124—Continued.

	Cache la Poudre at cañon.	Skyline.	Sand Crk. Ditch.	Grand R. Ditch.	Michigan Ditch.	Poudre V. Ditch.	No. Poudre Canal.	Net run-off at cañon.	Percent of normal.
1907.....	369,510	15 024	5,400	12,612	3,980	28,210	25,520	386,224	130
1908.....	244.169	17,958	2,092	16,775	4,123	23,546	26,076	252.843	85
1909.....	448,124	12.725	0	15,593	3,752	26,160	43,788	486,002	163
1910.....	150.116	16,435	783	9,883	2 308	15,551	21,256	157,514	53
1911.....	234,490	19,085	4 418	13,442	2.842	2,068	8,840	205,611	69
1912.....	306,702	20,986	2,157	15,741	4,746	9,150	25,500	297,722	100
1913.....	208,329	14,639	0	12,214	3,747	5,670	34,560	217,959	73
Mean								297,322	

°Estimated.

G. L. C. Mar. 4. '14.

The run-off as determined by records direct and without making allowance for trans-mountain accessions or for diversions above gauging station differs less than one would expect from the percentage as determined by making such allowances. The net run-off of Cache la Poudre River after making allowances shows nearly 3,000 acre feet more than if allowances were not made. This is difference, however, of only about 1%. The reason there is so little difference is that aggregate amount coming into Poudre from other water sheds is nearly same as amount diverted by two canals above gaug-
3399 ing station. Without this explanation the coincidence would be remarkable.

Explaining table Defendants' Exhibit 124, in column one is the year, in column two is shown discharge of river for different years or portions of years and is taken from last column of Exhibit 123. Third column headed "Sky Line" is discharge of Sky Line canal for years 1899 to 1913 inclusive, that is to say, it represents amount of water brought from Laramie River to Cache la Poudre River by Sky Line Canal during those years. Fourth column headed "Sand Creek" ditch gives amount of water which has been carried over from Sand Creek or Laramie River drainage, into Cache la Poudre drainage and covers years 1902 to 1913 inclusive. That column does not take into consideration any difference between water from Deadman and water from Sand Creek, it is the total from both those sources delivered by Sand Creek Ditch into Poudre River. In fifth column is shown amount of water brought over by Grand River Ditch from Grand River into Poudre drainage. In sixth column is shown amount of water brought across divide by Michigan Ditch and in seventh column is shown diversion by Poudre Valley Ditch of water above gauging station. In eighth column is shown diversion by North Poudre Canal above gauging station. In ninth column is shown net run-off at cañon and this represents amount of water which would pass gauging station had there been no diversions above and had there been no inflow into Poudre drainage from other drainages.

This net is obtained by subtracting inflow from Sky Line, Sand Creek, Grand River and Michigan Ditches, and adding outflow or diversion through Poudre Valley Ditch and North Poudre
3400 Canal. In last Column is given per cent. of run-off for different years as related to average flow for 30 year period. This column indicates what relative amount of water during different years discharged by Poudre River is to average as shown by 30 years' records.

I take 30 years average as being normal. 1911 amount of water discharged by Cache la Poudre River as compared by determined normal was 69%.

1912 shows 100% and was almost exactly normal.

1913 discharge of Poudre River was 73% of normal.

There is reason why I desire to consider flow of Cache la Poudre River in connection with my discussion of this subject. It is in order to use percentage of run-off for different years so that in examining records on Laramie River which are very much shorter than

records on Poudre, that is, they cover much fewer years, we will be able to tell whether those years covered by such records are
3401 above or below normal. It is to enable me to tell whether the Laramie River records are above or below normal.

From records on Cache la Poudre, Laramie and other streams, it is my judgment that run-off for November, December, January, February and March is about 2% for each month. 2% of total for year. October is perhaps 3% and April 4% of total for year.

On table Exhibit 124 will be found discharge of Sky Line and Sand Creek or Divide Ditch. Figures shown on exhibit will be used in connection with discussion of Laramie River drainage, for reason that this water has been diverted from Laramie River and so has augmented flow of Cache la Poudre River and has decreased flow of Laramie. In discussing, therefore, records of different gauging stations on Laramie, these quantities must be added to give true run-off from water shed above gauging stations, and by such additions many erratic conditions found on records of Laramie River can be explained. In diversion of water from one water shed to another, there is a greater percentage of water supply furnished by district from which water is taken during low year than during high year, that is, percentage of water diverted from Laramie River over to Poudre River during year of low flow is larger in comparison with flow of that year than water diverted in high year is to water flow during that year. For example, amount of water diverted through Sky Line Ditch would be more clearly constant from year to year than would average flow in Laramie River from year to year. Reason is that during year of low flow on Laramie River there would probably be a year of low flow on Poudre, which would create greater demand on Poudre for water and probably greater effort
3402 would be made to bring more water during low year. On other hand in high year, it would probably not be so necessary and the same effort would not be made.

Diversion of any considerable amount of water during a very low year would make a considerable difference in low water records on Laramie, but even diversion of somewhat greater quantity of water in high year would not seriously affect percentage of flow left in Laramie River. This discrepancy between percentage of water diversion and natural flow of stream makes it necessary to take into account amount carried over divide.

In table, Exhibit 124, discharge of Poudre Valley ditch for years 1904 and 1905 was estimated, as I had no records from Poudre Valley Ditch for those two years. These estimates were made after considering quantity of water available during those two years, demands of older ditches and amount of water diverted during years of similar flow. In 1903 we have statement that water was run in month of July. 1904 was second year in which water was run through Poudre Valley Ditch, but I have estimated this flow at only 15,000 acre feet, for reason that it was a new ditch. They would hardly dare carry the full quantity and there would not be full demand. That was reason for making amount diverted by Poudre Valley Ditch in 1904 less than discharge for year 1908, for instance, when

supply was less. In other words my estimate is very conservative. I estimated, taking everything into consideration, what to best of my judgment the amount was and could scarcely say whether it is too high or too low.

3403 Similarly, in year 1905 I estimated discharge as 20,000 acre feet, although in year 1907, a year of somewhat similar discharge, there was more water carried than what I show for 1905. I gave some consideration in this case to fact that it was new ditch, covering comparatively new district where demand would be less and where danger of breaking ditch would be greater.

For purpose for which this table is used, absolute accuracy or exact estimates are not essential. Even a variation of one per cent. would call for a difference of some 3,000 acre feet. Errors, if any, will, I think, be compensating, so that result given in last column is substantially correct.

Table is prepared on a blank form which carries along at top of columns names of months. These have no connection whatever with the figures on the table in this particular exhibit. They really should have been erased.

Figures shown in this table as to amount carried by Sand Creek or Divide Ditch will differ somewhat from figures which will be used in connection with the hydrographic data on Laramie River, for reason that Divide Ditch discharges into Poudre drainage not only water from Laramie River but also water from Sand Creek. Proportion to be credited to each of these streams is not definitely known, but through records of accounts kept in purchase and sale of water in this ditch, I have endeavored to separate Laramie River supply from that furnished by Sand Creek. By Laramie River supply I refer to that diverted from Deadman Creek through Wilson Supply Ditch. As amount diverted, however, is very small, even a very considerable error in any one year would mean a very little difference when merged with other records. Entire consid-

3404 eration of amount diverted by this canal in considering Laramie run-off, might be eliminated without affecting final results materially. A captious person could, with some show of reason, criticize nearly any record of a river, but method of making measurements is reasonably correct.

The hydrographers, generally speaking, have been men of experience and men who were disinterested, had no interest one way or the other in the results of their measurements and their sole object was to ascertain the facts. The measurement of the supply is based upon the cubic feet per second as determined by meter measurements.

In this table I have computed cubic feet per second into acre feet. Records are originally made in cubic feet per second, but in stating total run-off for year it is more convenient to use term "acre feet" as applied to actual volume under consideration. Distribution of canals, duty of water and all other matters relating to use of water for irrigation are determined almost entirely by meter measurements by hydrographers, and if there is any error in method of measurement differences will apply equally to supply, duty and use, so that relation between flow, use and other things connected

with water are relative rather than absolute and for all practical purposes can be taken as correct.

One is justified in casting aside records, if he has knowledge of serious errors or mistakes, or if he has knowledge that records are unreliable. An experienced man might also examine records critically and be able to say that they represent impossible conditions. He might also call into question accuracy of records, if records at adjacent gauging stations are not reconcilable with one under consideration. When I say an experienced man might examine records showing impossible conditions, I am speaking in the abstract and not of my own exhibits. It is a general statement. I will have occasion to question some records later on and therefore make that statement at this time.

3405 Duty of original water of Cache la Poudre River that is discharged by river at gauging station at mouth of cañon, service it performs and duty of return seepage water have been considered by me from different standpoints from what other writers have viewed the subject.

In considering duty of water, attention has generally been given by investigators to duty as applied to small tracts or to a lateral and sometimes to a ditch or an irrigation system. The efforts seem to have been to ascertain requirements of irrigated crops based upon amount of water measured at land, that is, at point of application. In construction of irrigation works, engineer of necessity has had to consider loss in transit, as well as needs of plant and needs at point of application. In this way engineer has rather broadened scope of determining duty of water and covered a larger field. He has considered irrigation project as a whole and so has been forced to determine duty of water in that regard.

Little work has been done to determine what I consider to be real duty of water. "Duty of water" is a technical term used by engineers and irrigators and is generally taken to mean the actual use on each particular tract of land or in the particular section under discussion. In a different sense it might be taken as the accomplishment which might reasonably be expected. Whether or not water does its full duty is question which affects the economics of irrigation.

In a new country, one might ascertain what the amount of water in the stream was, its annual flow, the yearly variations and the discharge during different portions of the year. With the quantity thus ascertained or estimated, and what might reasonably be expected in way of accomplishment from this water, he might predict final limit of development for that valley. The only definite figures under these conditions, which one would have, would be the amount of original water available, and without reference to return seepage, losses in transit, losses in storage, etc. Ascertainment of what this original water would accomplish is of great importance to those districts which are not yet fully developed, such as on the Laramie Plains.

Irrigators in Cache la Poudre Valley, have, I think, reached more nearly real duty of water than in almost any other section. Water of Cache la Poudre, I might say, now performs almost its full duty.

There are some ditches in Poudre Valley which still use more water than is necessary. There is some water which escapes from the district and there is water also which passes out of the valley which cannot be used in valley on account of its location. This is
3407 general except seepage water or return flow. Water which passes out of Poudre Valley into South Platte River is used by ditches heading on South Platte River below mouth of Cache la Poudre.

Questions naturally arising relative to this general subject in Poudre Valley are: First, what is amount of water that enters the valley and second what amount flows out of the valley into other districts and third what is amount of land irrigated in the valley and finally what is relation between amount of original water entering valley and area irrigated after deducting amount discharged from district into other districts.

By original water I mean natural flow without taking into consideration amount which returns to river after having been once used or diverted, that is, water running as waste or seepage. This waste or seepage water is a secondary use and sometimes called a reuse of water and it forms a very important part of the supply, but in determining what might be the area which would be irrigated in any valley, we are almost confined to amount of water which we find entering valley. We do not know what the return seepage will be, but knowing what the accomplishment in other districts has been, expressed in terms of original water, we should be able to predict with considerable accuracy the amount of land which ultimately might be cultivated in the new district.

Streams which issue from mountains onto plains are discharging their maximum amount at time they reach the plains. As
3408 the stream crosses the plains there are few tributaries. These are small and furnish very little water so that the amount of water measured at mouth of cañon or at foothills is more than is found after stream has traversed plains for any considerable distance. On Poudre River there originally was only probably an appreciable loss between mouth of cañon and mouth of river as there are practically no running streams entering Poudre River below mouth of cañon and above the mouth of the river.

Where streams cross plains in arid region they are to be contrasted with streams in regions of greater rainfall in this: Streams in arid region constantly decrease after they leave original source of supply, whereas streams of more humid region as a rule constantly increase.

Further discussing duty of water in Cache la Poudre River, I will state that I have submitted two tables Exhibits 123 and 124 and have shown on these tables amount of water available.

Average amount of water furnished by Cache la Poudre River itself, as previously stated, in a period of 30 years was 297,322 acre feet for the portion of the year between April and October inclusive. I have also previously stated that these seven months furnish about 90% of total annual flow. This would therefore give an annual discharge of 330,350 acre feet, which for purpose of this discussion we will call in round numbers 330,000 acre feet. This quantity, as has

been explained, has been obtained by adding to discharge at gauging station amount of diversions above gauging stations and sub-
3409 tracting amount of water coming in from other water sheds. These are shown in detail on Defendant's Exhibit 124.

On other hand if we take records at gauging station itself and add to them amount of water which did not pass gauging station by reason of diversions above, we get total supply entering valley by way of Cache la Poudre River. I consider it better, in determining duty of water to take flow of river in past ten years, rather than for full thirty years, for reason that I found it impossible to get full records of diversions of North Poudre Canal, amount supplied by Sky Line Canal in its early years was so uncertain also, and as amount of land under cultivation has been constantly increasing, it seems better to consider last ten years rather than whole thirty.

Average flow passing Cache la Poudre gauging station for last ten years, beginning with year 1904, April to October inclusive, was 289,438 acre feet. Flow April to October being 90% of annual flow, annual flow would be 321,600 acre feet. Instead of using 90% as giving yearly discharge, we could add to average flow for these ten years' average flow for the five winter months as shown on Exhibit 123. I would add to the ten year record for the seven months the average winter flow as based on all records which we have.

When I speak of ten year record, I mean average of the ten year record. That is adding for the five months, 4,966 acre feet for January, 4,475 acre feet for February, 4,260 acre feet for March, 4,706 acre feet for November, and 3,759 acre feet for December to the amount 289,438, which would give a total supply of
3410 311,604 acre feet. The difference by the two methods is nearly 10,000 acre feet.

As previously explained, our records for winter months are generally for years of low water and amount determined by using these records would therefore be too low. It appears reasonable to assume an average between the two totals given and to call the normal amount of water available for years 1904 to 1913 inclusive, 316,500 acre feet per annum.

This being the average annual amount passing the gauging station, we must add amount diverted above gauging station by Poudre Valley Canal and North Poudre Canal. North Poudre Canal, during these years, diverted an average of 24,080 acre feet, while Poudre Valley Ditch diverted an average of 16,733 acre feet, making a total of 357,313 acre feet.

Some water enters valley of Cache la Poudre from Fossil Creek by way of Fossil Creek Reservoir and some enters by way of small tributaries on north side of river below gauging station. There is, however, some land outside of district controlled by Water Commissioner which is irrigated by Poudre Valley water and on these streams there are small ditches which consume greater part of water and these areas being not included in estimate of Water Commissioner of amount of land in district, so that excluding both land and water on these tributary streams, eliminates necessity of adding that supply to Poudre supply. Some water, however, does enter district,

amount of which it is almost impossible to determine, it is not great however, and for purpose of this discussion I have called this amount 10,000 acre feet.

367,313 acre feet would be total supply of Cache la Poudre River.

Cache la Poudre Valley is in no way surrounded by moun-
3411 tains or hills after it leaves cañon. These minor tributaries, such as Fossil Creek, which I have mentioned, are merely torrential streams which furnish a very erratic amount of water, if they furnish any to the stream. I allowed 10,000 acre feet of water from those sources.

Amount of water which flows out of the district, that is, is discharged from Cache la Poudre River into South Platte River, as shown by records in office of State Engineer, is about 110,000 acre feet per annum. There is an almost constant discharge at all times of the year at the mouth of the Cache la Poudre of 50 cubic feet per second and at times there is very considerable more water.

It is also necessary at times to send water from District No. 3, the Cache la Poudre District, into District No. 1, and District No. 64, the South Platte Districts, for use in those districts. These districts are down the Platte below the mouth of the Poudre. This sending of water down into these lower districts is especially necessary during that period when reservoirs are being filled on Poudre. Ditches on Platte demand water for direct use as opposed to reservoirs demanding water for storage in upper district.

In addition to amount discharged through the Poudre River itself, there is a considerable amount of water which originates in the Poudre River but is discharged into the Platte River below the mouth of the Poudre. The seepage return which passes out of Poudre River into the Platte, as I say, is 50 cubic feet per second or more. This nearly all originates between the headgate of the

Greeley No. 3 Canal and the gauging station which is a few
3412 miles below the town of Greeley and also a few miles above mouth of river. Headgate of Greeley No. 3 Canal is five miles west and above town of Greeley. I make this statement in order to show how much water might be expected to return in these short distances. The Ogilvie Ditch takes out of the Cache la Poudre River slightly below Greeley and takes a considerable part of this return seepage which accumulates below the headgate of the Greeley No. 3 Canal. The Boyd and Freeman Ditch and the Camp Brothers Ditch, both below City of Greeley, divert portion of this return seepage water, but notwithstanding these diversions, there is something like 50 cubic feet per second being discharged constantly into South Platte River. I do not mean to say that all of the seepage and return to Poudre River reaches the stream below the headgate of the Greeley No. 3 Ditch.

The seepage and return water that reaches the river above the Greeley No. 3 Canal is taken out by various ditches, particularly by Greeley No. 3 itself.

Considerable water reaches the Platte River directly. This water originated in the Poudre River. This amount is not readily deter-

minable. My first estimates are to effect that it was about 20,000 acre feet per annum. In order to be well within any possible error, I have placed this at only 10,000 acre feet per annum. Adding this to 110,000 acre feet which discharges from Poudre, we have total of 120,000 acre feet per annum.

247,313 acre feet is the net amount of water consumed by the lands irrigated by the Cache la Poudre ditches and is the net consumption in the Poudre Valley. It is obtained by subtracting 120,000 acre feet from 367,313 acre feet.

3413 I have reports from official source as to number of acres irrigated in Cache la Poudre Valley. Water Commissioners are required under law to report amount of land irrigated in their districts. The reports of Water Commissioners are compiled in office of State Engineer and published in reports of State Engineer. These amounts as taken from reports of State Engineer for Cache la Poudre Valley are as follows:—1897—166,500 acres; 1898 records are incomplete; 1899 it is stated as about 172,000 acres; 1900 at about 186,000 acres; 1901 about 190,000 acres; 1902 about 97,910 acres, this is obviously an error as there was no falling off of the irrigated acreage in 1902. I think it probable that the figure should have been 197,910 instead of 97,910 acres. It might also be due to fact that Water Commissioner for that year made incomplete returns. Reports for 1903 and 1904 are not given. Report of State Engineer for these years never having been published. In 1905 area is given as 174,742 acres; 1906 about 209,118; 1907 about 200,120; 1908 about 203,890; 1909 about 207,455; 1910 about 212,940; 1911 about 248,480 and 1912 about 224,180 acres. These records, assuming them to be correct so far as they go, are not complete records of irrigated area of Cache la Poudre Valley. There is considerable area not reported on at all. Only those ditches were reported on which water commissioner had duties to perform. Those which are not included, being some of the small river ditches, that is ditches covering bottom lands along the river, but more particularly ditches which used seepage water flowing in gulches and small streams which water never reaches the river. There are quite a number of these last named ditches. In the aggregate there would be considerable area, although under any one of them it would probably be quite small, a few hundred acres.

Figures given are amount of land reported to have been irrigated. Amount of land under ditch was also reported in 1912. In that year it was reported as 376,750 acres. This figure, however, included amount of land in the Greeley-Poudre Irrigation District. By deducting 125,000 acres from amount given by reports, amount of land under ditch outside of Greeley-Poudre Irrigation district was 251,750 acres.

Exact quantity of land irrigated in Cache la Poudre Valley is not known, but it is safe to say that it was between 250,000 and 275,000 acres, probably more even that 275,000 acres. I have assumed something of an average between 250,000 and 275,000 acres and for purpose of this discussion I call the irrigated area 265,000 acres.

Difference between amount irrigated and that under ditch is ac-

counted for by land which, lying fallow, happened from any cause not to have been irrigated for that particular season or was occupied by ditches, reservoirs, roads, corrals etc. Properly speaking these areas should be included in total, as they constitute a part of the irrigation plant, for example, if a man owns 160 acres and ten acres are occupied by rights of way, corrals and other uses such as I have mentioned, it is a part of his plant and we generally say that his entire 160 acres was irrigated. The Water Commissioner, however, in making his report takes actual acreage irrigated in each different crop and aggregate of these he calls total irrigated acres and in this way he misses entirely land occupied by reservoirs, roads etc.

3415 300,000 acres of land are irrigated or irrigable in the Poudre Valley. In my experience, amount of unirrigated land in district similar to the Poudre Valley would be about 15%.

247,313 acre feet was net consumption of water in Cache la Poudre Valley as already shown.

265,000 acres of land are irrigated in the valley as already stated. This is rather a restricted definition of irrigated land. It does not take into consideration the exceptions already noted.

Duty of water in this valley based upon amount of original water entering the valley is less than one acre foot per acre.

To verify this duty of water based on amount of original water entering valley and disregarding return seepage, I might recall testimony of A. A. Edwards, one of witnesses in this case. He testified that under The Water Supply and Storage Company's system, there is about 50,000 acres; average consumption was something over 60,000 acre feet per annum or about 1.2 acre feet per annum. By use and re-use of water made possible through return seepage, duty of the district as a whole as shown is less than one acre foot per annum per acre.

This duty, in my opinion, will rise somewhat and it may be that sometime in the future the duty of water in the district as a whole, measured in terms of original water entering the district, will rise to ¾ of an acre foot per acre per annum in terms of original water entering the district.

3416 Under the present methods of irrigation and the present incentive toward economical use, I believe that one can assume that the duty of water where the rainfall, climate, soil and crops are such as they are in the Poudre Valley, the real duty and accomplishment which might reasonably be expected, will be less than one acre foot per annum per acre and the use and the duty as measured at the headgate of ditches would be not more than 1.25 acre feet per annum per acre.

Under the assumption of elim-ation entirely the 120,000 acre feet, passing into South Platte River from Poudre Valley, and considering only the amount of original water which enters valley, which I have given as 367,313 acre feet, the duty would be about 1 1/3 acre feet per acre per annum. But that hardly means anything, because regardless of what water of necessity passes out of valley, there is still an amount which is forced out of valley, that

is out of District No. 3 for the use of ditches below, at least that quantity should be deducted from amount of original supply, because part of that water which is so forced out of district is original water.

Considering subject from original water suppply alone used in Poudre Valley, duty of water would be less than 1 1/3 acre feet per annum per acre. We speak of it as the duty of water being higher, that is, the accomplishment greater.

I have placed 10,000 acre feet per annum as total inflow into the Cache la Poudre River between the canon and the mouth. A large portion of this is return seepage which comes to stream above the head of Greeley No. 3 Canal. The elimination of this 10,000 acre feet from the total supply of the valley would make very little difference in the ultimate figures. Considering only the original water which enters the valley and is about 357,000 acre feet, in round numbers, the duty would still be about 1 1/3 acre feet per annum per acre. Under the first assumption, to be more correct, duty would be about 1.38 acre feet per annum per acre and in latter case where 10,000 acre feet is eliminated, duty would be 1.35 acre feet per annum per acre. Elimination of the 10,000 acre feet would make a difference of only .03 acre feet per acre per annum.

The figures just given, it will be observed, show a lower duty of water than that accomplished on the system of The Water Supply and Storage Company, according to the testimony of Mr. Edwards. That shows that discharge from Poudre River into South Platte River must be deducted or should be deducted.

Actual practice disproves any idea which might be advanced against discharge of water from Poudre River into Platte, according to experience of Mr. Edwards, as Preisdent and Manager of The Water Supply and Storage Company.

There is a gauging station at Glendevey on Laramie River in Colorado. That station is about nine miles below west portal
3418 of the Greeley-Poudre Irrigation District's tunnel. Records for this station are for 1904, July to October inclusive; 1905, April to October inclusive; 1910, August 15 to November 30 inclusive; 1911, January 1 to November 30, inclusive; 1912, January 1 to November 30, inclusive; 1913, April 21 to October 19 inclusive.

(Defendants' Exhibit 125, Table showing flow of Laramie River at Glendevey, offered in evidence.)

(COPY OF DEFENDANTS' EXHIBIT 125.)

State of Colorado—Engineering Department.

Discharge of Laramie River at Glendevey, Colo., for 1904–05, '10, '11, '12, '13.

Drainage Area, 102 Square Miles.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1904.....	.....	.....	.....	.....	.....	.....	10.140	3,898	1,886	1,636	.....	.....	
1905.....	.....	.....	.....	1,862	14,798	37,310	9,961	3,732	1,101	523	.....	.....	
1910.....	.....	.....	.....	.....	.....	.....	.....	.....	2,499	2,214	1 607	.....	
1911.....	998	714	1,248	2 309	15,096	29,151	8,144	2,323	1,571	2,152	1,174	.....	
1912.....	1,200	906	1,119	1,194	12,619	32,276	16 374	3,298	2,200	2,297	1,468	.....	
1913.....	.....	.....	.....	4,000	12,113	11,840	3,911	1,962	1,654	2,000	.....	.....	
Mean..	1,099	810	1,184	2,341	13,656	27 644	9,706	3,043	1,818	1,804	1,412	1,200°	65,717

° NOTE.—Mean for December estimated.
Table showing average run-off in acre ft. for each month.
Mean yearly flow 65,717 acre ft.—12 plus inches in depth.
Mean yearly flow including Laramie River Ditch 83,790 acre feet—15 plus inches.
Mean yearly flow including Laramie River Ditch and Water diverted through Sand Creek about 86 150 acre feet—15.8 inches.

Defendants' Exhibit 125 is table which I have prepared showing flow of Laramie River at Glendevey rating station. Flow of water is expressed in acre feet. This is shown for each month of the several years of which we have record, together with mean discharge for each of months. Aggregate discharge of all the months, as shown by mean, giving as a result average flow for year at gauging station. It also gives total including diversions by Laramie River Ditch (Sky Line Ditch) and by the Wilson Supply Ditch, the discharge of these two ditches being added to annual discharge passing the station.

Glendevey rating station is on Laramie River at point about 15 miles due south from Colorado-Wyoming line, just below mouth
of Deadman Creek, that is, point where Deadman Creek
3419 enters Laramie River. It is some nine miles below tunnel of
the Greeley-Poudre Irrigation system and about 14 miles north of Chambers Lake. It is below Rawah Creek which is one of larger tributaries of Laramie River. It is about 10 miles above mouth of McIntyre Creek. It is very close to northerly or upper end of East Side Collection Ditch and some 4 miles in due northerly direction from upper or northerly end of West Side Collection Ditch. The station is below all of the inter-mountain diversion systems from the Laramie River, except that diverted from Sand Creek and with the exception of possible diversion from McIntyre Creek which we have generally called The Lower McIntyre Diversion.

The Lower McIntyre Diversion is the only remaining extension of this system which is possible under geographical conditions surrounding it. I should add, that at extreme head of McIntyre Creek there are some 2 square miles of territory which will be tapped by Upper Rawah Ditch. Speaking with reference to drainage areas, the Glendevey station is above this area of 2 miles at head of McIntyre. Otherwise Glendevey station is below all the diversions and all of the water which can be diverted by the Greeley-Poudre system, by the Sky Line or the Wilson Supply or Divide Ditch and all water diverted by these canals will pass this station.

65,717 acre feet per annum is mean flow of river at Glendevey station, as given by Exhibit 125 and as shown by records which we
have. This Exhibit 125 needs perhaps a little explanation
3420 in order to avoid confusion and explanation later. Record
for October, 1913, was estimated from a partial record of that month. Partial record gave 19 days equal to 1,313 acre feet. I have assumed for whole month 2,000 acre feet. Records for June, 1904, are not recorded; record for that portion of that month was so short that I did not feel able to fill out the discharge for that month from so short a record. In 1910 record, although about one-half of month of August is given on original records, I made no attempt to fill out that month. 1911 there is no change in the record. 1912 records are quite complete from January to November inclusive, and no changes were made. 1913, as previously stated, month of October was filled out and also month of April. For last

10 days of April discharge was 1,395 feet, for entire month of April I have given it in round numbers as 4,000 acre feet. Discharge for month of October is generally more than that of September. Amount of water seems to increase as weather gets colder, due in part to loss of evaporation during cooler weather and in part to fall rains.

65,717 acre feet is actual run-off according to this record at this particular point as shown by table.

This discharge record at this station does not include water diverted by Sky Line Ditch of The Water Supply and Storage Company, nor by The Wilson Supply Ditch, which I have previously mentioned.

86,160 acre feet is mean yearly flow of Laramie River at Glendevey rating station, if water diverted through Sky Line Ditch and Wilson Supply Ditch is added to the amount actually flowing past the station. This figure was obtained by adding discharge of those two ditches to 65,717, while previous figure, 83,790 acre feet was obtained by adding discharge of Sky Line or Laramie River
3421 Ditch to 65,717. When on this table, Exhibit 125, I include Sand Creek Ditch, I only refer to the upper portion of ditch which diverts water from Deadman Creek and which is known also as the Wilson Supply Ditch. This table does not show water diverted into Poudre water shed from Sand Creek alone, but does show the portion which comes from Deadman into Sand River Creek and then later into the Poudre.

Explaining the legend "Mean yearly flow, 65,717 acre feet equals 12 plus inches in depth." I will state:—The drainage area is 102 square miles or 65,280 acres, above this station. A discharge of 65,717 acre feet from this area would be a little in excess of one foot or twelve inches per acre. I therefore put it 12 plus inches, indicating that depth of run-off through this period of which we have record over this water shed comprising about 102 square miles was about one foot in depth over entire drainage area. This 65,717 acre feet, however, does not represent total supply furnished by this water shed, part of it having been diverted through Sky Line Ditch and Divide Ditch. Adding amounts that were diverted to amount as shown at gauging station, and on same basis of 102 square miles, the drainage area, we find that the run-off expressed in depth over the entire drainage area including the Sky Line is 15.4 inches, while adding diversions through the Wilson Supply Ditch and the Sky Line ditch the run-off over the water shed was 15.8 inches. This 15.8 inches might be assumed to show as indicated by records given, that this water shed discharges 15.8 inches of water for the entire water shed.

3422 Expressing it otherwise, Sky Line Ditch, or, as noted on the exhibit, the Laramie River Ditch, and the Wilson Supply Ditch, or, as noted on exhibit, the Sand Creek Ditch, would divert a quantity which might be represented by 3 plus inches over the entire water shed. Taking the Wilson Supply Ditch alone, its supply of water diverted from Deadman Creek would be represented by .4 of one inch over the entire water shed. By the water shed I

mean to be understood as referring to the restricted water shed which I before mentioned of 102 square miles.

By referring to measurements on Laramie River and those on Poudre River, for purpose of arriving at basis of normal flow, I will state that years of which we have record at the Glendevey station were probably below normal. The table, Exhibit 124, showing percentage of run-off in Cache la Poudre River, and another table which I will submit later of the flow of the Laramie River at Woods Landing for the different years for which we have record, as compared with average shown by yearly record, indicates that these years when there were records taken at Glendevey, namely 1904, 1905, 1910, 1911, 1912 and 1913, in combination gave an average of 87% of normal based on Poudre records. These years based on Woods Landing records gave an average of 84.5% of normal. The records of this station are not entirely satisfactory. The year 1910 the record was very short, but I have assumed that these years in combination are 85% of normal.

Normal discharge of Laramie River at Glendevey rating station, actually passing that station, would be about 77,000 acre feet per annum, on the basis above mentioned, instead of 65,717 acre feet as actually shown by the records of the years we have.

Estimate of run-off of area above Sky Line Canal and discharge from Sky Line Canal indicates that that canal carries about 75½%
of total supply furnished by watershed above the ditch, from
3423 Laramie drainage into the Poudre. Developments under Greeley-Poudre system will probably be little if any more efficient, although it will be able to divert the winter flow furnished by that portion of drainage area lying above the tunnel.

Winter flow of Laramie River at mouth of tunnel will be about 10 cubic feet per second of time during the winter months. Except under unusual conditions, it will be impossible to carry water through the Collection Ditches during the winter. They will freeze over, probably would entirely choke with ice. Some water might be run, but the delay in opening up in the spring and the danger of such proceeding, in my judgment, would almost preclude possibility of carrying water in winter through those two ditches, so that efficiency of system might be somewhat greater than efficiency of Sky Line and this system might divert from 70% to 75% of water passing Glendevey rating station. This would be with aid of the two Collection Ditches. There is some considerable area below the collecting ditches whose water passes Glendevey station, all of these things considered, about 75% of run-off could be carried to and through the tunnel.

This measures total amount of water which can be diverted to and through the Greeley-Poudre tunnel, with the exception of what might be diverted by possible construction of extension of West Side Collection Ditch to the McIntyre.

Confirming this estimate of 77,000 acre feet of water as the normal
amount actually now passing the Glendevey rating station,
3424 year 1912 is approximately normal. We have records fairly complete for that year and flow as shown by records for that

year was 74,950 acre feet, to which I added 1,050 acre feet as estimated flow for month of December, this would give a total of 76,000 and seems to confirm or at least checks quite closely with other method or timate which gave 77,000 acre feet.

56,000 acre feet, in round numbers, I assume could be diverted through the Greeley-Poudre tunnel. This figure is about 74% of the 77,000 acre feet, and if there is any error I think the figure is perhaps a little high. I have included in this 56,000 acre feet, the diversion from 2 square miles area at the head of the McIntyre Creek.

The extension of the West Side Collection Ditch to McIntyre Creek, according to suggested plan, would tap an area of about 26 square miles or about 15,640 acres. We have records on McIntyre Creek near point where such extension would tap the stream. We also have records at the mouth of McIntyre. I understand that this extension of this ditch to McIntyre Creek is very problematical and that it represents a possibility and not a probability.

The extension of the West Side Collection Ditch to McIntyre Creek, would represent the ultimate and only possible future development and extension of diversions of water from Laramie River to the Cache la Poudre River.

3425 My estimate that 70% to 75% of water at Glendevey station can be taken to and through the tunnel, refers only to water at present passing Glendevey station, after Laramie River (Sky Line Ditch) diversion and Wilson Supply Ditch (Sand Creek Ditch) diversion from Deadman and Laramie River have been made. At this point, in order to make that matter clear, I would say that my estimate for diversion from 2 square miles at head of McIntyre Creek is 3000 acre feet. While this does not represent a total run-off of that area, yet in view of probable lateness of season at that high altitude, limited capacity of Collection Ditches, etc., I think it is about what we could expect to divert from that source.

If Lower McIntyre extension is built, water which had not been diverted by Upper Rawah Ditch, which taps it, would of course be available at lower station. I have estimated that flow of McIntyre at its mouth is 34,250 acre feet per annum. Deducting from this the 3,000 acre feet which will be diverted by Upper Rawah Ditch, we have a net of 31,250 acre feet available at the mouth of McIntyre Creek. The area which will be tapped by the Lower McIntyre extension ditch is about 19 square miles as against 49 square miles for the entire McIntyre. Probably 2/5 of this discharge originates in this 19 square miles or about 20,000 acre feet of water. If this is case we are able to divert 75% of water passing at head of this extension and we would secure 15,000 acre feet in addition to the 3,000 acre feet diverted from the Upper McIntyre. Reason for not giving entire flow of McIntyre, as available to tunnel, is because high water on McIntyre exceeds capacity of proposed extension canal and exceeds at times capacity of West Side Collection Ditch as now planned and partially constructed. It accordingly seems that 15,000 acre feet is as much as could be diverted from the lower McIntyre.

The total ultimate development of the Greeley-Poudre system might therefore reach a diversion of 56,000 acre feet plus 15,000 acre feet or 71,000 acre feet.

This added to what the Sky Land Ditch might divert and also what the Divide (Wilson Supply Ditch) Ditch might divert, 18,000 acre feet in case of Sky Line and 2,000 acre feet in case of Divide, would indicate an ultimate possible diversion from Laramie water shed of 91,000 acre feet, but in all probability this diversion will be limited to 76,000 acre feet. This latter figure is obtained by assuming only 56,000 acre feet as the ultimate diversion through the tunnel instead of 71,000 acre feet.

18,000 acre feet credited to Laramie River Ditch (Sky Line Ditch) is based on what has been done in past, average diversion in past being something less than 18,000 acre feet per annum.

Heard testimony of Mr. Whitting, a witness for State of Wyoming. He gave list of ditches on Laramie River in Colorado. Of these ditches, so far as I know, only the Long Park No. 2, and Link Ditches No. 1 and No. 2 divert their waters above Glendevey

3427 Station.

Next rating station below Glendevey is at Boswell's or Decker's. Boswell's Station is about ½ mile north of Colorado-Wyoming line in State of Wyoming, while Decker's station is about ½ mile south of interstate line. These two stations were supposed to be the same, although there is one considerable tributary called Stuck Creek which comes in to the river between the two stations. They were established, I believe in order to determine amount of water which is passing out of Colorado into Wyoming. Think they were first established by United States Geological Survey, that is to say, the Decker's ranch station in 1904.

In order to utilize both sets of records, it is necessary of course to make allowance for amount of water which enters Big Laramie River between the two stations. We have records of this creek, Stuck Creek, for 1912 and 1913.

3428 Stuck Creek enters river between the two stations from the west and comes from high mountain area constituting divide between North Platte River drainage and Laramie River drainage. The 1912 record of Stuck Creek, was made by Professor L. G. Carpenter and the 1913 records were made under direction of State Engineer of Colorado. Discharge measurements in these two years were made about twice a week, and it is assumed in estimating flow of Stuck Creek, that these measurements represent average amount of discharge between dates of actual measurements. Records made by Professor L. G. Carpenter, cover period from May 27 to July 5, 1912. I have estimated discharge for 1912 on Stuck Creek based on these measurements.

Cross-examination by Mr. N. E. Corthell:

Records on Stuck Creek were made once a week perhaps in 1912 by Professor Carpenter and in 1913 by one of hydrographers of State Engineer's office. These records were made on Stuck Creek. Previous measurements at Decker's and Boswell's stations were made

on river alone. They were in years 1904, 1905, 1906 and 1908, a considerable period before we measured Stuck Creek flow. Concerning Stuck Creek I am testifying about 1912 and 1913 flows.

Direct examination by Mr. Fred Farrar:

In order there may be no confusion, the statement which I have made relative to measurements for 1912 and 1913 refer solely to Stuck Creek. I am not yet talking about measurements made at Decker's or Boswell's. In 1912 measurements on Stuck Creek for month of June were five in number and I estimated flow for
3429 that month as 3451 acre feet. Discharge for May based on two measurements I estimated at 1735 acre feet. Discharge for July, based on two measurements I calculated to be 1435 acre feet, with the result that I estimate the annual flow of Stuck creek for year 1912 to be about 8815 acre feet. In 1913 measurements were made by hydrographer for State Engineer's office of Colorado and in May six such measurements were made. From these measurements I estimate discharge for that month at 2048 acre feet. In June ten measurements were taken and from these ten measurements I estimate discharge for month of June at 904 acre feet. In July ten measurements were taken and from these I estimate discharge for that month was 156 acre feet. Last measurement was made on July 31, when one cubic foot of water per second of time was running and I have called discharge for the month of August one cubic foot per second or 61.5 acre feet for the month. One cubic foot per second would be about two acre feet per day. The aggregate discharge for 1913 May, June and July was 3108 acre feet. Assuming these three months ran 70% of the annual flow, I estimate annual discharge for 1913 for Stuck Creek at 4440 acre feet.

Year 1912 was approximately normal in discharge of water in this vicinity, while discharge for 1913 was only about 51% of normal.

Normal discharge of Stuck Creek, based on 1913 records at 51% would therefore be 8800 acre feet. My conclusion is that this creek discharges normally about 9000 acre feet per annum.

In utilizing records at Decker Station on Big Laramie River, and combining them with those of Boswell Station records, it is necessary to make allowance of 9000 acre feet annually from Stuck Creek and other territory draining into river between the two stations. I have prepared a table giving records of discharge of Big Laramie River at Decker's and Boswell's and this table will be used in connection with discussion of discharge at these stations and across Colorado state line into Wyoming.

(Defendants' Exhibit 126, table showing flow of water at Decker's and Boswell's Stations, offered in evidence.)

(COPY OF DEFENDANTS' EXHIBIT 126.)

State of Colorado—Engineering Department.

Discharge of Laramie River at Decker's and Boswell's Ranches.

Decker's Ranch.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
1904.....	.....	.....	.....	.....	.....	.....	12,746	4,067	2,547	2,577	.....	.....	22,537
1905.....	.....	.....	.....	2,981	28,160	69,020	13,040	6,014	2,356	1,703	.....	.....	123,274
1906.....	.....	.....	.....	.....	52,000	51,763	17,954	8,240	6,800	.....	.....	.....	136,763
1908.....	.....	.....	2,500	3,392	15,822	34,402	12,328	8,093	6,200	.....	.....	.....	82,737
Total..	.....	.....	2500	6,373	95,982	155,191	56,068	27,014	17,903	4,280	.....	.....	.....
Mean..	.....	.....	2,500	3,186	31,994	51,730	14,017	6,754	4,476	2,140	.....	.....	116,797

Boswell's Ranch.

1911.....	.....	.....	.....	.....	37,000	47,125	13,684	4,389	2,563	4,185	3,709	.....	112,655
1912.....	.....	.....	.....	4,500	32,783	92,912	34,087	7 545	5,078	5,343	3,405	.....	185,653
1913.....	.....	.....	.....	10,500	31,742	26,214	8,287	3,400	3,004	4,366	3,332	.....	90,935
Total..	.....	.....	.....	15,000	101 525	166,251	56,058	15,334	10,735	13,894	10,446	.....	.....
Mean..	.....	.....	.....	7,500	33.842	55,417	18,686	5 111	3,578	4,631	3,482	.....	132,247

Defendants' Exhibit 126 shows flows at these two stations. Units are expressed in acre feet. Table covers records at Decker's Ranch as follows: 1904, July to October; 1905, April to October; 1906, May to September; and 1908, March to September. Boswell's Ranch records cover following periods: 1911, May to November inclusive; 1912, April to November inclusive; 1913, April to November inclusive.

In estimating from these records, what the normal discharge past these two stations is, it is necessary to take percentages as indicated by Cache la Poudre River for reason that there are no records for 1904, 1905, 1906 and 1908 at Woods Landing. That is, it is necessary to take the percentages of flow based upon the normal. We can, however, use percentages on Laramie River itself for year- 1911,
1912 and 1913. Mean flow based on average for those three
3431 years would not be as safe an estimate of normal as one based on thirty years.

Taking percentage as shown on Poudre and at Woods Landing Stations we find that normal discharge based on this table would be about 155,000 acre feet, to which should be added amount of water which was diverted across divide from Laramie River into Poudre drainage. I assume diversions of those two canals during those periods to average about 20,000 acre feet per year. This is the amount diverted out of the water shed.

After making deductions of 9,000 acre feet for amount of water entering river between the two stations, then I combine records with those at Boswell's and assume that the records were at same point, with the result, as I have said, that the discharge appears to be about 155,000 acre feet per annum. But during these years, I have assumed that there were diversions from Laramie River averaging 20,000 acre feet, which waters were taken out of water shed. Had these not been made, discharge past these stations would have been about 175,000 acre feet.

There is considerable water originating in state of Colorado, which does not enter Laramie River until river has passed into Wyoming. Water from several creeks and particularly Johnson and Beaver Creeks on the west side of Laramie River, head in Colorado but discharge their waters below Boswell gauging station, so that in order to determine amount of water which passes from Colorado into Wyoming, these creeks must also be taken into account. Johnson and Beaver Creeks I have estimated discharge 22,000 acre feet of water per annum, which originated in Colorado.

These creeks derive some water from Wyoming, but in explanation of how the 22,000 acre feet was obtained for Johnson and
Beaver Creeks, I wish to say that we have record of discharge
3432 of those two creeks for 1912 and 1913. These records were taken in manner similar to the ones taken on Stuck Creek. In 1912 the discharge of Johnson Creek, practically all of which originates in Colorado, I estimate at 16,000 acre feet per annum and I estimate discharge of Beaver Creek, based on measurements of 1912 and 1913 at 11,500 acre feet. Larger part of water of Beaver Creek probably comes from State of Colorado, and I

have credited to Colorado 6,000 acre feet of the 11,500 acre feet. In 1913 a number of measurements were taken on these two creeks. On Johnson Creek as follows:—April 28 and 29, two measurements; in May, six measurements; in June, seven measurements; July six measurements; for May, June and July aggregate on Johnson Creek was 2628 acre feet. Assuming that those months yield 70% of the total annual flow, flow for 1913 would be 3755 acre feet. There are, however, on these streams, two ditches which use a considerable per cent. of water, especially in years of low flow. The percentage in years of low flow of course, is actually greater than in years of high flow. On account of these diversions and variances occasioned thereby, in years of low flow, 1913 can hardly be taken as a basis. On the other hand 1912, which I have stated is approximately normal, shows a discharge for June of 4998 acre feet; for July, 3630 acre feet; for August, 1045 acre feet; for September, 310 acre feet; and for May, based on records of last half of month, flow for mouth was estimated at 2263 acre feet. This is flow of Johnson Creek. Making a total for May to September inclusive, of 12,246 acre feet, allowing for missing months, I have estimated discharge at 16,000 acre feet. I do not know exact location of ditches from Johnson and Beaver Creeks. It is my understanding that they are but a short distance above mouth. As Professor Carpenter made these measurements and is more familiar with them, I think he would be able to give that much better than I could, also discription of ditches. These ditches are in Wyoming.

Beaver Creek discharge I have estimated at 11,500 acre feet for year 1912, and that, being a normal year, I take it as approximately a normal discharge. Records of 1912 made by Professor Carpenter indicate discharge for May of 3064 acre feet; June, 2916 acre feet; July, 922 acre feet and it is on basis of these three months which aggregate 6902 acre feet, that I estimate annual discharge as 11,500 acre feet. About 9 square miles of better portion of drainage area of Beaver Creek are in State of Colorado. Map attached to the Answer of Corporate Defendants, Exhibit 1, indicates that there is nearly 9 miles of divide between Laramie and Platte River drainages in Colorado as against little more than 3 miles of such divide in State of Wyoming; so that notwithstanding smaller drainage area is in Colorado, fact that better drainage area is in Colorado leads me to conclusion that at least half of total discharge originates in Colorado. The 16,000 acre feet for Johnson Creek added to the 6,000 acre feet of Beaver Creek water originating in Colorado makes 22,000 acre feet from these two streams, which I have added in order to obtain total amount furnished by State of Colorado making a total of 197,000 acre feet.

This does not take into account any water which might be discharged into Wyoming from Colorado through Sand Creek. This 197,000 acre feet includes the Sky Line (Laramie River Ditch) and Wilson Supply (Sand Creek) Ditch. For sake of completing the record, I might say that in 1913 discharge of Beaver Creek for May, June and July aggregated 2,589 acre feet. Assuming that these three months represent 70% of annual flow, annual flow was 3,700

acre feet for 1913. 1913 was about one-half of the normal and normal as indicated by these 1913 records, would be 7,400 acre feet as against 11,500 acre feet as derived from records of 1912. There are however some ditches on this stream, and in periods of low flow that seriously affects the flow of the stream or rather the percentages of flow at the mouth, so that this year cannot be well used in estimating what the normal discharge of that stream might be.

Estimate of 197,000 acre feet is based upon records at both Decker's and Boswell's augmented by records of Stuck, Johnson and Beaver Creeks. Records at Decker Ranch are very questionable. In fact we have really two sets of records, one kept by Water Commissioner in Laramie River District and one as published by United States Geological Survey. They do not agree. Records as shown by Water Commissioner being very much higher. Station at Decker's was established in 1904 and the hydrographer, Mr. Lamb, who was making measurements in that year, furnished Water Commissioner with a rating table and from this rating table discharge was es-
3435 timated. Mr. Decker kept record of gauge heights at this station and was also the water commissioner. He was considered a very reliable man, and as far as records of gauge heights are concerned, I think there is no question of their reliability. I have taken the rating table as furnished by the hydrographer, Mr. Lamb, to Water Commissioner Mr. Decker, and have made discharge table for 1904, with result that in month of July, 1904, by the Lamb rating table, discharge was 14,193 acre feet as against 12,746 acre feet as published by the Geological Survey. It is published in Water Supply Papers No. 131 and 172 of U. S. Geo. Survey. In August by Lamb rating table the discharge was 5922 acre feet as against 4667 acre feet as published. In September discharge by Lamb rating table was 3453 acre feet as against 2547 acre feet published record. In October Lamb rating table gave discharge of 3403 acre feet as against 2577 acre feet as published. In October Lamb rating table gave discharge of 3493 acre feet as against 2577 acre feet as published. The aggregate for months July to October by Lamb rating table is 27,061 acre feet as against 22,537 acre feet as published.

In table for Decker Station as shown on Exhibit 126 I have used lower or published record. I also used published record for 1905. This I might say was equally an error, reliability of records of that year are certainly questionable.

Examining discharge at Glendevey rating station for July, 1904, and comparing it with published record at Decker's for same month and same year, inflow between Glendevey and Boswell's, according to published records, was only 2606 acre feet. McIntyre and other considerable tributaries enter river between those two stations and it is
3436 certain that a greater amount of water than 2606 acre feet entered river during the month of July, 1904. This to my mind proves unreliability of published records.

I therefore have found it necessary to discard this estimate of normal flow at state line as determined by Boswell and Decker records combined, that is, I have thought it necessary to discard the figure

197,000 acre feet as being the amount even approximately which is contributed by State of Colorado to Laramie drainage.

This discrepancy between the Lamb rating table and the published records occurs through the fact that the rating table was worked out on the ground in all probability and furished Mr. Decker, so that he might have an idea of how much water was passing into Wyoming. The table was something of a preliminary nature, to be sure, but the published records were prepared several years after the date when the records were made. They were prepared in Washington, probably by someone who had no personal knowledge of the locality or the conditions. In a footnote in the published records, statement is made that certain of gaugings were probably too high because of a defective meter. That is a statement but scarcely an explanation. If meter was defective, it would give a lower discharge and amount of discharge should have been raised rather than lowered.

That would be true in all cases of a defective meter, discharge would be given lower than the actual fact. Anything which might happen to meter would cause it to run slower rather than faster. I think that would invariably be case.

Custom was for records to be worked up in Washington by clerks and that very fact has caused considerable trouble to those who have examined Government publications critically and it has cast doubt on the reliability in many instances. I think hydrographer who
3437 made measurements was decidedly better qualified to construct rating curve than someone unacquainted with local conditions or with methods of making measurements, and especially after a year or more had elapsed. Mr. Lamb, the hydrographer whom I have mentioned, was connected with U. S. Geological Survey.

Regardless of what explanation might be made or what theory might have been used in computing figures shown in published record, fact remains that they are considerably lower than rating table made by the hydrographer Mr. Lamb. And, further than that discharges as given, when considered in connection with discharge at Glendevey rating station above, prove conclusively to my mind that the Decker Station records were much too low and I feel justified therefore in discarding the published records.

Exhibit 126, in so far as it relates to discharge at Decker Station, should not be used.

A more accurate method at arriving at an accurate determination of amount of water discharged across interstate line, than that given by these records, would be to take discharge records at Boswell Station proper, eliminating records at Decker Station. I wish to state further in respect to records at Boswell's and Decker's, that years of record at Decker Ranch indicates a discharge of 116,797 acre feet, March to October inclusive, while records at Boswell Ranch April to November is 132,247 acre feet. These are on different
3438 years.

Normal flow of Poudre River, as previously testified, was determined by taking mean for period of 30 years at gauging station at mouth of Poudre.

Normal flow of Laramie River, using Laramie records exclusively,

was obtained at Woods Landing Station. Taking years covered by Decker records, but not those records themselves, those years in combination, so far as flow of Laramie River is concerned, give mean flow of 101% of normal.

Years shown by Boswell records are below normal. Using Cache la Poudre percentages, they were 81% of normal and using Woods Landing records, they were 85% of normal. In other words, eliminating Decker records and Boswell records as shown on Exhibit 126, I mean to state that years 1904, 1905, 1906 and 1908, when taken in combination were 101% of normal.

Years 1911, 1912 and 1913 were below normal and amount to 81% based upon normal as determined by Poudre flow, and 85% as based on normal as determined by Laramie River flow measured at Woods Landing station.

I have made calculation to determine amount of water passing state line in Laramie River. I used several methods for purpose of checking myself and to ascertain what different possible combinations might bring forth. A little later I will take my more detailed discussion of Woods Landing record, but for present I wish to use table which I have constructed relating to Woods Landing Station, as I need this table in determining run-off across state line from Woods Landing records.

(Defendants' Exhibit 127, table showing Woods Landing records, offered in evidence.)

(COPY OF DEFENDANTS' EXHIBIT 127.)

State of Colorado—Engineering Department.

Discharge of Laramie River (Net Run-off in Acre Feet) at Woods Landing (Apr. to Oct.) for 1895–1900 and 1911–1913.

	Woods Landing.	Skyline Canal.	Sand Crk. Ditch.	Net run-off, Woods Landing.	Per cent.	Per cent, normal.
1895.....	220,239	15,787	.....	236,026	109	105
1896.....	108,022	16,282	.....	124,304	58	55
1897.....	251,074	16,897	.....	267,971	124	119
1898.....	117,765	12,790	.....	130,555	60	58
1899.....	390,730	17,699	.....	408,429	189	182
1900.....	248,105	18 657	.....	266,762	123	119
1911.....	138,240	19,085	4,418	161,743	75	72
1912.....	213,407	20 986	2,157	236,550	109	104
1913.....	99,221	14,639	0	113,860	53	51
Mean....	198,545	.....	.....	216,244		

Cache la Poudre same years—96.1 % Normal—225,000 ac. ft.

Unless otherwise noted, all discharges are in acre feet.

C. L. C. M'ch 5, '14.

Exhibit 127 gives discharge at Woods Landing for years for which we have record, beginning with and subsequent to 1895. Woods Landing Station is about 9 miles due north of Colorado-Wyoming line. It is above the Laramie Plains. It is, you might say, extreme southerly end of Laramie Plains on Laramie River. River comes through cañon immediately above this station. From that point down Laramie Plains region begins to spread out on each side of river.

Table Exhibit 127 shows there was a mean discharge for 9 years given at Woods Landing of 198,545 acre feet. That is, the average of the first column on table is equal to that amount. This amount does not take into account either the winter flow or records at Woods Landing for years 1889, 1890, 1891, 1892 and 1893. The reason will be explained later.

3440 Period of year covered by figures on table, Exhibit 127, is for months of April to October, inclusive. I designate these months, November to March inclusive, as winter months. The seven months that I have shown in the table cover the irrigation season that is shown in column one. In column two is discharge of Sky Line Canal. Column three gives discharge of Divide or Sand Creek Canal. Column four is sum of first three columns. Column five is percentage of run-off of different years based on mean run-off of 216,244 acre feet and last column is correction of percentage based on percentage of flows on Cache la Poudre River. The length of these records is not quite sufficient to give mean sufficiently accurate.

Unit of flow, with exception of percentage columns, is expressed in acre feet. Complete records for Woods Landing Station, as far as I have been able to find them, are recorded in another table which I have prepared and in order to make the record complete I desire to refer somewhat to that table also.

(Defendants' Exhibit 128, containing complete records for Woods Landing Station, offered in evidence.)

(COPY OF DEFENDANTS' EXHIBIT 128.)

State of Colorado—Engineering Department.

Discharge of Laramie River (Run-off in Acre Feet) at Wood's Landing, Wyoming.

Drainage Area 393 Square Miles.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1889....	.....	.....	.....	10 000°	35.558	53,730	17 409	8,481	3,699	3,472a	14,400a	26,150a	166,899
1890....	14,198a	15,904a	15,801a	9,118b	56,157	58,278	23,219	11,619	4,890	5,125b	12,360a	7,160a	233 829
1891....	10,106a	15,456a	21,080a	16,440a	54,014	66,831	32,621	16,427	9,591	11,222a	6,840a	7,440a	268.068
1892....	20,900a	17,200a	10,270a	10,350a	27,500	74,500	.....	.....	.....	.....	.....	.....	160 720
1893....	14,651	26,123	.....	.....	.....	80,309	32,138	10,696	7,258a	3,704a	7,924a	7,020a	149.049
1894....	No record.												
1895....	.....	.....	.....	9,722	74,241	78,480	11,870	3,456	438	[illegible]	658	.....	179.440
1896....	.....	.....	.....	12.000	38,400	29,900	7,690	5,870	6,902	7 260	.....	.....	108.022
1897....	4,304	3,888	4,304	7,617	120,762	93,064	16,356	5,718	3,868	3,689	3,868	4,304	271,742
1898....	.....	.....	.....	7 676	39,106	57,659	5,472	2,705	2.380	2 767	6,444a	.....	124.209
1899....	46,116	39,987	44,271	33,977	78,950	191,663	77,044	11,744	3,332	3,997	4,165	9,223	544,469
1900....	10,945	11,718	10,699	7,438	119,286	105,679	7,010	3,074	2,618	.....	.....	.....	278.467
1911....	.....	.....	.....	.....	45,500	56 100	14.900	4,770	1,760	4,650	3,000	.....	130,680
1912....	.....	.....	.....	5,534	40.643	91,874	34,863	7,809	4,641	6,456	4 403	2.644	198,867
1913....	.....	.....	.....	.....	35,847	27,431	9,223	4,610	4,700	5,410	.....	.....	87,221
Total.	121,220	130,276	106,425	129.872	765 964	1,065.498	289,815	96,979	56,077	58,327	64,062	57,941	
Mean.	17,317	18,611	17,738	11,807	58,920	76,107	22.293	7,460	4.314	4 861	6,406	8,277	254,111

April 1 to Dec. 31—200,445 acre feet.
April 1 to October 31—185,762 " "

°Last 15 days was 6,406 acre feet.
aEstimated by Deputy State Engineer of Wyo. from unpublished gauge height records.
bRecords of State Engineer of Wyo.

This table, as I stated, contains all of data that I was able to secure for Woods Landing Station. It will be noted that a number of discharges credited to different months have letter "A" above them. These figures so indicated were estimates made by the then Deputy State Engineer of Wyoming, Mr. Harry True, I think, in year 1911 from unpublished gauge height records in office of State Engineer of Wyoming, and this table was prepared at the instance, I believe, of officers of the Greeley-Poudre Irrigation District, so that they might ascertain as nearly as practicable the run-off on Laramie River at that time.

Table compiled by Deputy State Engineer of Wyoming was furnished me by Mr. John R. Wortham, Engineer of the Greeley-Poudre Irrigation District.

Had all of these records been used in determining annual discharge at Woods Landing, discharge exclusive of diversions by Sky Line and Divide Ditches would have been 254,111 acre feet according to the table Exhibit 126. Previous records of discharge would appear to be that amount. Some of winter records, however, are questionable, and excluding all of winter records, that is months of January, February and March, average discharge for that portion of year exclusive of those months would have been 200,445 acre feet. Excluding, in addition to those months, months of November and December, discharge would have been 185,762 acre feet. That would be amount for April to October inclusive.

Records subsequent to 1894 appear to be more reliable, less open to question. For purposes of calculation affecting amount of water furnished by Laramie River from State of Colorado, I have used only years subsequent to 1894 and furthermore have taken only the records between April and October as basis. Winter records were not numerous and one at least I think was unreliable, discharge for January, February and March, 1899. Those are very much above records for average for those three months. I discarded records giving largest amounts for those three months.

3442 I give this explanation at this time, so as to show my reason for limiting figures on Exhibit 127 to years subsequent to 1894 and limiting them to months April to October inclusive.

Discharge of Laramie River as shown on Exhibit 127 is 198,545 acre feet, exclusive of Sky Line and Divide or Wilson Supply diversions. Months April to October inclusive, as I have previously stated, represent about 90% of annual flow. Average discharge for whole year therefore based on this table would be 220,490 acre feet. All these years in combination represent 96% of normal, as compared with percentages determined on Cache la Poudre River. Normal on this basis would be 230,000 acre feet. To those should be added diversions of Sky Line and Divide Ditches which estimate 20,000 acre feet. Had these diversions not been made, amount passing Woods Landing Station would have been 250,000 acre feet for a normal year.

In discussing Boswell Station discharge, I have stated that there were about 22,000 acre feet coming into river between Boswell's Station and Woods Landing Station. This is water furnished by

State of Colorado. Total inflow between two stations I estimated at 35,000 acre feet. Difference between 35,000 acre feet total inflow and 22,000 acre feet furnished by Colorado, is 13,000 acre feet. Deducting this amount from 250,000 acre feet passing Woods Landing station would leave 237,000 acre feet as furnished by State of Colorado. The figure 198,545 acre feet is not shown on
table, Exhibit 127, but that is average or mean of the first
3443 column

If exact amount of water diverted by Sky Line and Divide Ditches had been added to flow as shown on Column 1 in Exhibit 127, mean discharge including diversions of two canals would have been 216,244 acre feet. These years as previously stated are 96.1% of normal. This would result in a normal in round numbers of 225,000 acre feet which is merely arriving at practically the same point by a different method.

I wish to call attention at this time to amount which I have allowed as winter flow and that shown by actual record on Exhibit 128. Aggregate of winter months as shown by mean on said Exhibit aggregates 68,349 acre feet, while I have allowed but 32,000 acre feet on Exhibit 127. Flow for winter months, November, December for 1912 and January, February and March, November and December for 1913, have been given by Mr. R. I. Meeker in connection with his tables with reference to Pioneer Dam. Discharge for winter months for 1913 aggregates 14,924 acre feet according to Mr. Meeker.

Using 216,244 acre feet as shown on Exhibit 127 as gross run-off, April to October, inclusive, run-off based first on 96.1% with reference to the Poudre and the seven months at 90% of total year we have, discharge for normal year at Woods Landing 250,000 acre feet. Again deducting 13,000 acre feet, amount furnished by State of Wyoming at that point, discharge is again 237,000 acre feet.

Referring again to records at Boswell Station, one may make an estimate of discharge across interstate line from records at that station, omitting Decker Station records. Boswell Station records, April to November inclusive, average 132,247 acre feet, to which should be added 20,000 acre feet for Sky Line and Divide Canal diversions. These eight months represent about 92% of annual
flow. Annual flow therefore, including Sky Line and Divide
3444 Ditches would be 165,700 acre feet. The three years 1911,
1912 and 1913 represent 72,104 and 51 per cent. respectively of normal flow as shown by records at Woods Landing, that is, as shown by last column on Exhibit 127, was in combination 75%. On this basis of 75%, the discharge would be 220,933 acre feet, to which must again be added discharge by Johnson and Beaver Creeks of 22,000 acre feet. We therefore have a discharge across state line of 242,933 acre feet.

Still another method of arriving at this discharge and perhaps confirmatory of the figures already given, is to consider the year 1912, which was approximately normal, at Woods Landing. The discharge as shown on Exhibit 127, after making due allowance for Sky Line and Divide Ditches, for period April to October inclusive,

is 236,550 acre feet. This period again being 90% of the total annual discharge, the annual discharge would be 262,830 acre feet. Perhaps it would be better in this case, however, to take records for winter rather than using 90% as I have done heretofore. If this were done, total discharge at Woods Landing for year 1912 would be 256,396 acre feet. 1912, however, by Exhibit 127 appears to be 104% of normal. Normal therefore would be 246,500 acre feet, from which, however, must be deducted the 13,000 acre feet which passes this gauging station and originates in Wyoming, which would leave 233,500 acre feet as amount furnished Wyoming by Laramie River from Colorado.

Still another method of arriving at this discharge from Colorado will be obtained by taking records at Boswell station again of 182,248 acre feet, amount furnished in 1912 April to October inclusive, and adding thereto amount diverted in 1912 by Sky Line and Divide Ditches of 23,143 acre feet, giving total of 205,391 acre feet. This again on basis of 90% of discharge for that period of year would result in annual discharge being 228,821 acre feet, to which must again be added Colorado water furnished by Johnson and Beaver Creeks, namely 22,000 acre feet, giving total discharge across state line by Colorado water shed of 250,821 acre feet, being total for year 1912. 1912 was 104% of normal, as shown on Exhibit 127. Normal therefore would be about 242,000 acre feet.

These various methods of calculation agree quite closely with exception of results obtained by using Decker Ranch tables which we have discarded for reasons which I have stated.

By other methods of calculation we have 237,000 acre feet, 233,000 acre feet, and 242,000 acre feet, the average of which is 237,500 acre feet. This figure we may assume to be amount which is derived from Colorado exclusive of supply furnished by Sand Creek, they being based on reliable figures.

Sand Creek drainage in Colorado is about 50,000 acres from which run-off should be one-third of an acre foot per acre or in round numbers 17,000 acre feet.

254,500 acre feet is amount of water furnished Laramie River by Colorado, obtained by adding 17,000 acre feet from Sand Creek to the 237,500 acre feet average above stated. Colorado is at present diverting about 20,000 acre feet per annum or 8% through Sky Line and Divide Ditches. A previously stated, Greeley-Poudre Irrigation District may take 56,000 acre feet or 22% more and if Lower McIntyre Extension Ditch development should be added to that now planned, diversion would be 71,000 acre feet or a total of 28% including this development, and a total maximum development possible in all Colorado diversions would be 36% of the supply which the State of Colorado itself furnishes to the Big Laramie drainage. Even eliminating supply which is furnished by Sand Creek, 17,000 acre feet, and on basis of a total diversion of 91,000 acre feet, there would be diverted 38.4% of the amount
3446 furnished by Colorado. This is assuming Sand Creek supplied nothing whatever to Wyoming and assuming that ultimate possible diversions were accomplished.

38.4% would then represent extreme diversion which will be possible under any circumstances from Laramie River in Colorado and assuming in addition thereto that Sand Creek furnished no source of supply to the river whatever. With the flow of Sand Creek estimated as furnishing 17,000 acre feet per annum to the river, the extreme and ultimate possible diversion within Colorado would be 36% of the total flow of the Laramie River arising in Colorado. Without construction of a ditch which would tap the Lower McIntyre in the manner mentioned, the diversion would be 30% of the Laramie River water originating in Colorado.

Reversing the proposition, the fact is that with Sky Line Ditch diversion, Sand Creek or Divide Canal diversion, coupled with diversion through the Greeley-Poudre system, 70% of the water of the Laramie River water-shed rising within the State of Colorado must pass into the State of Wyoming, and that, notwithstanding anything which Colorado might do in future with exception of one extension to the Lower McIntyre. Wyoming is seeking in
3447 this action not only the 70% of the Colorado water which it must and will always receive, but in addition to that, the 22% of the Colorado water which it is proposed to divert through the Greeley-Poudre tunnel.

The year 1912 was approximately normal, determined by examination of 30 years' records on Cache la Poudre. Water sheds of two streams are adjacent and similar and one would expect percentage of flow to be similar. There would be differences in taking individual years, but taking several years, percentages should and did agree quite closely. I also arrived at that conclusion by an examination of the Woods Landing records themselves. Run-off was not 100% of normal, but was, as I have stated, 104% of normal. Had I, however, used Exhibit 122 and all of the records as shown thereon, and had I used records furnished by R. I. Meeker with reference to discharge at Pioneer Dam and confined myself solely to records of Big Laramie at Woods Landing, percentage of 1912 in respect to mean flow would have been 101%.

It seems to make little difference in fact whether one uses Woods Landing records exclusively or uses those in connection with records of Cache la Poudre. There could be but a difference of not to exceed 5%. For instance on Exhibit 127, 1912, or rather for that portion of the year 1912 April to October, is shown as 109% of normal, based on Woods Landing record subsequent to 1894, but it is well known fact and well recognized, that winter flow of year 1912 was considerably below normal. If we did include those winter records which were below normal, percentage would have been less actually than 109% shown. On Exhibit 127 I have this note:—"Cache la Poudre same years equals 96.1%, normal equals 225,000 acre feet." I mean by that that normal amount of flow in Laramie River at Woods Landing according to this table for years given and from April to October, would have been 225,000 acre feet, based upon determination of normal on the Poudre River.

At Woods Landing Station we have records more or less complete and more or less authentic and reliable for years 1889 to 1900 in-

clusive, with exception of year 1894. We also have records for 1911, 1912 and 1913, the only records. Most of them at least are not entirely above suspicion, probably on account of ice conditions and fragmentary conditions of records and lack of sufficient number of actual gauge readings during winter. 1912 record as shown on Exhibit 128, was amount given by R. I. Meeker in his tables showing discharge at Pioneer Dam. These records are from April to December inclusive for 1912. This amount for 1912 given by Mr. Meeker is open to serious question, especially for months of June and July, for reason that amounts given for those months for Pioneer Dam station are less than discharge for same months of that year at Boswell Station, notwithstanding that there is very considerable run-off during those two months from territory lying in between the two stations.

3448 (Defendants' Exhibit 129, table of discharges at Woods Landing 1911, '12 and '13, and for Boswell Ranch Station same years, offered in evidence.)

(COPY OF DEFENDANTS' EXHIBIT 129.)

State of Colorado—Engineering Department.

Discharge of Laramie River (Run-off in Acre Feet) Showing Differences in Flow Boswell's (Decker's) and Wood's Landing. These Differences Represent Inflow Between the Two Stations.

		Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
1911.	Wood's Landing.....				7,000	42,600	58,100	15,600	7,100	3,190	4 650	.....	.....	
	Bosswell's Ranch.....				.....	37,000	47,125	13,684	4,389	2,536	4,185	.....	.....	
	Difference (inflow).....				.....	5,600	10,975	1,916	2,711	664	465	.....	.....	22,311
1912.	Wood's Landing.....				6,134	42 497	102,826	39,639	9.590	6 228	6,493	4,305	3,800	
	Bosswell's Ranch.....				4,500	32,783	92,912	34,087	7,545	5,078	5,343	3,405	.....	
	Difference (inflow).....				1,634	9,714	9,914	5 552	2,045	1,150	1,150	900	.....	32,059
1913.	Wood's Landing.....				12,000	35,847	27,431	9,223	4,610	4,700	5,410	3,377	3,246	
	Bosswell's Ranch.....				10,500	31 724	26,214	8,287	3,400	3,094	4,366	3,332	.....	
	Difference (inflow).....				1,500	4,123	1,217	936	1,210	1 606	1,044	45	.....	11,681

Unless otherwise noted, all discharges are in acre feet.

G. L. C. M'ch 5, '14.

Defendants' Exhibit 129 is table of discharges prepared by me, showing discharge at Woods Landing for 1911, 1912 and 1913 and for Boswell Station for same years. Difference in discharge of two stations is given in third line for three years and in last column to right of table is given total difference between discharge of two stations for period of year covered by records. This table is presented to show what the inflow during these years was be-
3449 tween the two stations. In 1911 difference of discharge between two stations was 5600 acre feet for month of May; 10,975 acre feet for month of June; 1916 acre feet for month of July; 2700 acre feet for month of August; 664 acre feet for month of September; and 465 acre feet for month of October, which month ends record for that year. Total difference between two stations for this year, 1911, being 22,311 acre feet. There was that much more water at Woods Landing than at Boswell's. 1911 was year of less than normal flow, in fact, from percentage tables presented heretofore, 1911 is shown to be about 72% of normal for Laramie River. In year 1913 difference between two stations was April 1500 acre feet, this figure however is based on estimates of discharge for that month for Woods Landing, records themselves, however, show that for month of May difference in discharge was 4123 acre feet; June 1217 acre feet; July 936 acre feet; August 1210 acre feet; September 1616 acre feet; October 1044 acre feet and November 45 acre feet, total difference of inflow for period April to November being 11,681 acre feet. This year 1913 was one of about 51% of normal flow.

It appears from records shown on table Exhibit 128, that record submitted by Mr. R. I. Meeker for 1912 for Pioneer Dam Station, is probably more than 10,000 feet too small for month of June and 20,000 acre feet too small for the year. The figures given by Mr. R. I. Meeker appear on a portion of table Plaintiff's Exhibit I.

As I previously stated years 1889, 1890, 1891, 1892 and 1893, on which we have records at Woods Landing, were discarded. A portion of these records was taken from report of State Engineer of Wyoming and balance was obtained as previously stated in 1911 from then Deputy State Engineer Harry True. He also furnished other compilation from unpublished data in Office of State Engineer. These are the ones I stated I discarded from my compilation. The use of that portion of table prior to 1895 does not affect materially final results for portion of year between April 1 and October 31.

Using all records mean annual flow at Woods Landing Station as shown is 254,111 cubic feet of which, as previously stated, 200,445 acre feet was discharged between April 1 and December 1 and 185,272 acre feet between April 1 and October 31. All these figures are shown on Exhibit 128.

If we eliminate very high and possibly questionable records for November, these being for years 1889, 1890, 1891, 1893 and 1895, average for November would be changed from 6406 acre feet as a mean, to 4386 acre feet as a mean. Records for December are also somewhat questionable, but using December, 1897 discharge which

amount was 4304 acre feet and 1889 of 9223 acre feet and 1912 of 2644 acre feet, average discharge in December would be 5390 acre feet inflow and 8277 acre feet if all records were used. It is well known fact that flow for November and December, 1912, was very low. Flow for 1911 in November at this station on Exhibit 128 I have placed at 3000 acre feet. That is also probably too low because records at Boswell station for same month in same year give discharge of 3405 acre feet. If we assume average for these 5 winter months of 5000 acre feet and discharge as shown on Exhibit, April 1 to October 31, of 185,762 acre feet, average discharge at Woods Landing would be 210,762 acre feet, to which we would add the diversions through the Sky Line and the Divide or Sand Creek Ditches, approximating 20,000 acre feet, making total run-off at Woods Landing 230,762 acre feet.

3451 These years are about 90% of normal and normal would therefore be 256,484 acre feet. As records for this station in 1912 given on Exhibit 128 are not to be used, we cannot take that year as basis for analysis. However, even taking these figures for that particular year discharge was 198,867 acre feet, adding 20,000 acre feet for diversion of Sky Line and Divide or Sand Creek Ditches, discharge April 1 to October 31 is 218,867 acre feet and total for year would be 243,180 acre feet.

Returning to Exhibit 129 and referring to year 1911, if we supply difference of 1500 acre feet for month of April, then on basis of 90% we find that difference for entire year would be 26,456 acre feet. This year is shown to be about 72% of normal. The indicated normal therefore is 36,700 acre feet as normal which enters river between Station at Woods Landing and at Boswell's. In 1912 differences were necessarily largely estimated. In fact discharge for Woods Landing Station was based on discharge record at Boswell Station to which records I added discharge of Johnson and Beaver Creeks and discharge of intervening territory. Inflow based on discharge of these and other accretions appears to be 40,000 acre feet, but it was thought best to allow very little run-off for unknown territory outside of Johnson and Beaver Creeks and quantities given in table are conservative. In 1912 differences shown in table were: April, 1634 acre feet; May, 9714 acre feet; June, 9914 acre feet; July, 5552 acre feet; August, 2045 acre feet; September, 1150 acre feet; October 1150 acre feet; November 900 acre feet and a total of 32,000 acre feet, and for April to October 31,159 acre feet, which on a basis of 90% for that period, April to October, total discharge for year 1912 is 34,620 acre feet inflow between two stations.

As confirming estimate for 1913, differences between discharge at Boswell's and Woods Landing made by hydrographer for State Engineer's office of Colorado might be given. Measurements at Woods Landing were made whenever hydrographer was in that vicinity. In May six measurements were made at that station, June seven measurements, July five, August one, September one and October one. With these actual gaugings as basis differences for different months at two stations would be as follows: May, 5547 acre feet; June, 2211 acre feet; July, 381 acre feet; August, 380

acre feet, September, 586 acre feet and adding 1500 acre feet for April and 500 for October, we have total of 11,100 acre feet as differences, which seems to confirm differences as shown on table, that difference being 11,636 acre feet. These records differ as to individual months, but as a whole they are quite close together. Very low flow for months of July and October, 1913, is probably due to fact that most of water in tributaries of stream was being used during those months. I refer to streams entering Laramie River between Boswell's and Woods Landing, particularly Johnson and Beaver Creeks. Year 1913 was a little over ½ of normal and this taken in connection with use of water upon tributary streams, would indicate a normal between 30,000 and 40,000 acre feet. For purpose
3453 of this discussion, however, we have assumed that average inflow between Woods Landing and Boswell's was 35,000 acre feet, although, as stated before, measurements made in 1912 indicate an inflow of at least 40,000 acre feet.

Referring again to list of ditches given by Mr. Whitting, a witness for plaintiff, diverting water from Laramie River and tributaries in Colorado, all of those ditches are above the Boswell gauging station. So that any water that might be used by those ditches above Boswell's gauging station is of course in addition to the flow which I have given at that point. It is not shown by the records which I have submitted. Amount which I have submitted is net run-off after these ditches have been supplied. Only ditches that I have considered or for which I have made correction are the Sky Line Canal and the Divide or Sand Creek Ditch.

(End of Transcript Vol. 7—Defendants.)

3454 JOHN R. WORTHAM, recalled.

Direct examination by Mr. Delph E. Carpenter:

I ascertained by survey location irrigated areas of land in Laramie River Valley in Colorado. Survey started May 9, 1913, and suspended May 23, 1913. Resumed August 17th and completed September 5, 1913. Survey made by stadia method. Had survey party at time I was engaged in work. Consisted of A. I. Akin and Milo Eidson. After survey reduced my notes to maps. Ten sheets were required to make maps and plats of valley as reduced from notes. I have numbered those sheets in order to facilitate testimony in this case. They are numbered Sheets Nos. 40, 41, 42, 43, 43*a*, 43*b*, 44, 45, 46 and 47. I started with No. 40 because it would follow numbering of maps that were introduced by State Engineer under
3457 plane table survey, his last sheet being 39. I refer to plane table sheets contained in Defendants' Exhibit 114, reproduction of Laramie Plains' survey.

(Map consisting of ten sheets marked Defendants' Exhibit 130, Wortham Survey.)

Exhibit 130, consisting of ten sheets, are tracings made from surveys by stadia in Laramie River Valley, State of Colorado, from state line southward as far as any irrigation extended.

(Permission given to withdraw exhibit and to substitute therefor reproduction thereof, similar to Exhibit 114.)

All of Laramie River Valley in Colorado is shown on these sheets. The tributaries shown are La Garde Creek, McIntyre Creek, and a small stream called British Creek. Jimmy Creek and Grace Creek are omitted. I did not make plats showing irrigated lands on those two creeks. There are no other tributaries omitted upon which irrigated lands are situate. These sheets show irrigated lands in
Colorado Laramie River drainage except those on Jimmy
3456 and Grace Creeks. They do not show irrigated area on Sand
Creek and its tributaries in Colorado. Only attempted to show as to tributaries which entered Laramie River in Colorado. Sheets only include Big Laramie River area in Colorado. Some of irrigated lands shown on sheets as lying in Laramie River Valley, receive part or all of their water supply from tributaries of that stream which enter stream in Colorado.

Have designated irrigated tracts by giving owners of land irrigated, together with class of irrigation and acreage in each tract.

There are 2,939.5 acres of land irrigated and cut for hay in the Laramie River Valley in Colorado and the tributaries of that stream, exclusive of Jimmy Creek, Grace Creek, and Sand Creek. Total irrigated sage brush land 204.5 acres. Total irrigated timothy land, 34.6 acres. Total irrigated pasture 98.4 acres, and there are 13 acres plowed that have been irrigated but were not irrigated in 1913. This is located on Grace Creek Ranch. It is on Big Laramie River just below mouth of Grace Creek.

3,290 acres total irrigated acreage in Big Laramie River Valley in
Colorado, exclusive of Grace, Jimmy and Sand Creek areas.
3457 204.5 irrigated to sage brush is irrigated for purpose of
killing sage so that ground will finally become hay meadow. It is land in process of reclamation for native hay. It is not in class designated irrigated pasture (98.4 acres) because what I have classed as irrigated pasture is land that is already grown up to hay largely, but is dotted with plots of willows, jack pines and aspen, which would require removal of these trees in order to make pasture a hay meadow capable of being cut and harvested.

I found 98.4 acres of irrigated pasture out of total 3,290 acres of irrigated land in Laramie River drainage in Colorado, excepting creeks mentioned. This is outside of portion of sage brush land now in the operation of reclamation.

About 640 acres of land is irrigated on Jimmy Creek. A portion of that is irrigated from Big Laramie River. Mr. Mansfield irrigates possibly 320 acres from the Big Laramie River by the Timothy Ditch, and Diamond Ranch Company irrigates remaining one-half of section from Jimmy Creek.

About 320 acres is irrigated on Grace Creek.

4,250 acres would be the total irrigated lands in the Big Laramie Drainage, exclusive of Sand Creek and tributaries, including the
estimated acreage on Jimmy and Grace Creeks as given. Ir-
3458 rigation in Big Laramie Valley is by canals taking water from stream and tributaries. I have not located canals on

Exhibits, although in large measure, they would be located on outer boundaries of irrigated land. They would be on east and west sides of irrigated areas on that stream. Boundaries of various meadow tracts near foothills and mountains may be taken as approximately location of canals. They are all what might be termed "small canals."

Canals do not get more than about 1,000 feet from the thread of the stream as a rule.

Flood irrigation is method used by land owners in Laramie River Valley in Colorado. They turn water through their ditches and onto their meadows and allow this water to run for a period of 60 days. Water is continuously running over land and back into river. This is not in any way similar to the method of flood irrigation used in Cache la Poudre Valley in agricultural sections. In Laramie River Valley water is kept passing over land continuously, whereas in Cache la Poudre Valley it is applied and turned off and applied again for two or three successive irrigations. In Laramie River Valley water is kept circulating across meadows and back into stream, through irrigation period.

3459 On Sheet 43 there is a tract designated "irrigated sage brush flat." Effect of use of water on this sage brush flat was destruction of meadow below by the making of ponds and swamps on lands in river valley. When water on other meadows was shut down so that meadows could dry, return waters from irrigation of this sage brush flat at higher elevation, causes these lands to remain wet for long period, thereby lessening their value for hay meadow.

It would be detrimental to hay meadows to extend irrigation of Laramie River Valley to the flats immediately above and adjacent to present irrigated area. That seems to be general consensus of opinion of irrigators in that valley.

It would be impracticable to get any further irrigation on additional acreages over the present total, 4,250 acres. It is possible, in the valley itself, to clear land immediately next to the river and turn that into hay meadow. Even a major portion of that is so rough as to make it incapable of use for meadow. In upper portions this is especially true. Willows are dotted with beaver swamps

3460 and bog holes. With exception of addition of small tracts along margin of stream, down in immediate river flats, present irrigation development in Laramie River Valley in Colorado, is indicative of possible future development of that region. Acreage I have given would indicate approximate limit of extent to which state of Colorado and its citizens may go in utilizing waters of this, one of its streams. I refer to utilization of water within the valley itself.

(Defendants' Exhibit 130, Sheets of survey of irrigated lands in Laramie River Valley by Mr. Wortham, offered in evidence.)

Water applied to these river bottom lands, immediately adjacent to the Laramie River, all return quickly to the stream.

JOHN R. WORTHAM.

Cross-examination by Mr. John D. Clark:

3460 The Greeley-Poudre Irrigation District acquired from the Laramie-Poudre Reservoirs and Irrigation Company ranches
3461 in the upper Laramie Valley containing 716.1 acres of irrigated land including hay meadows and irrigated sage brush and irrigated pasture, and the district is now farming this land. I do not know the amount of water rights acquired in connection with these ranches. The ditches irrigating the
3462 land so acquired are the Long Park Ditch Number Two, the Link Ditch Number One, the Link Ditch Number Two, the Upper Hills or Upper Smith-Brown Ditch, the Hills Ditch, the Smith-Brown Ditch, the Yelton Ditch, the Homestead Ditch, the Comet Ditch, the Mansfield Ditch, and the Mansfield Number Two Ditch. The majority of the water applied to the land in the upper Laramie Valley returns rapidly to the stream, and there is not a large amount lost to the river from the irrigation of the hay meadows.

3463 Redirect examination by Mr. Fred Farrar:

Owing to the fact that most of the irrigated land in the Laramie River Valley in Colorado follows the thread of the stream, and owing to the fact that water discharged onto these lands returns quickly to the stream, there would not be very much evaporation.

3465 JOHN E. FIELD, recalled.

Direct examination by Mr. Fred Farrar:

Referring to Exhibit 128, concerning Woods Landing gauging station, records for year 1895, which commence with month of April and include April to November, are not correct. The original gaugings were looked up and a curve plotted, and from records of gauge heights, discharge was ascertained, with result that discharge April to November at Woods Landing should be 223,243 acre feet in lieu of 179,440 acre — as shown on Exhibit 128.

As I stated yesterday, Exhibit 128, shows original records as I found them, practically without change or criticism.

Record for year 1895 as shown on Exhibit 128 is portion of record furnished me by Harry True, formerly deputy state engineer of Wyoming. I wished to make this statement in order that there would be no confusion in use of Exhibit 127, which discharge 1895, April to October inclusive, is shown as 220,239 acre feet. That figure was derived by subtracting discharge for month of November of 3,004 acre feet.

Year 1912 is approximately normal regardless of method used in arriving at flow at Woods Landing for that year. There
3466 seems to be persistence, no matter what method of calculation is used. In using discharge of 1912 to have been approximately normal, for example, if I take Exhibit 128 and take

the discharge for 1912, as shown thereon, which amounts were given by Mr. Meeker in reference to Pioneer Dam, percentage of flow based on that record, and based on mean record shown in same exhibit, would be 99 per cent. If on same table I should eliminate high and possibly questionable records of November and December, 1889, and November, 1890, percentage would be 102.7 per cent. That would be percentage for 1912 flow. It thus appears it would not make a very great difference what method is pursued in determining whether or not the year 1912 is normal. Extreme variations seem to be at first from 95 per cent., to 109 per cent., but my final conclusion was that year 1912 on Laramie River was 104 per cent. of normal.

Normal flow of Poudre for year 1912 as shown on Exhibit 124 is 100 per cent.

There is substantial uniformity in percentage of flow based on normal in both streams, that is, that approximate normal occurs same year.

In my testimony relative to Poudre flow I mentioned fact that 1884 was abnormally large, according to table Exhibit 124, and that standing alone record might be subject to question, but that tradition has it that the year was one of abnormally large flow. By tradition I mean that people now living in Poudre Valley all speak of that year as being highest that ever occurred.

3467 They say that water during that year reached higher points than at any time since with exception of time when Chambers Lake Reservoir broke. It is not tradition; it is history, and is within the memory of men now living. It is also historically reported that river not only attained a very high flow but also that it remained at a high stage for a long period of time during that season.

Have compiled records of discharge of Little Laramie River. Have complied tables showing discharge Little Laramie River which I have called discharge at Hatton Station. Records of that stream have really been kept at two stations a short distance apart. Hatton Station is credited with 155 square miles drainage area, while Filmore Station is credited with 164 square miles drainage area. There is little drainage reaching river between two points and two stations might be considered as practically identical for determining flow of that stream. A second table was taken at the second Filmore Station, which I stated is very close to Hatton. There is station at Two Rivers, at mouth of Little Laramie River, where Little and Big Laramies join. There is gauging station on both streams at that point. That has been maintained by State Engineer's office of Wyoming in cooperation with Laramie Water Company, and I believe also at times with United States Geological Survey. These

3468 are the stations used by Mr. Meeker in his report and testimony.

(Table marked Defendants' Exhibit 131.)

(COPY OF DEFENDANTS' EXHIBIT 131.)

State of Colorado—Engineering Department.

Discharge of Little Laramie River at Hatton, Wyoming.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1902	....	....	....	....	....	....	5,600	1,660	2,856	2,828	2,265	....	15,209
1903	....	....	....	8,500	13,650	72,417	12,728	4,400	....	....	....	....	111,695
1911	....	....	....	....	16,500	32,400	7,930	2,400	1,240	2,320	....	....	62,790
1912	....	....	....	....	13,500	54,300	23,200	7,750	4,440	4,750	....	....	107,940
1913	1,045	1,000	1,476	4,554	18,600	20,844	4,851	1,844	1,107	1,562	1,642	1,070	59,595
Total ...	1,045	1,000	1,476	13,054	62,250	179,961	54,309	18,054	9,643	11,460	3,907	1,070	....
Mean ..	1,045	1,000	1,476	6,527	15,562	44,990	10,862	3,611	2,411	2,865	1,954	1,070	93,373

NOTE.—Records from 1902, 1903, 1911, 1912 at May's Ranch; Record for 1913 at Lake Hattie Inlet, plus flow in Belamy Canal, by R. I. Meeker.

Unless otherwise noted, all discharges are n acre feet.

Exhibit 131 gives monthly discharge Little Laramie River at Hatton, Wyoming for year 1902, July to November inclusive; 1903, April to August inclusive; 1911, May to October, inclusive; 1912, May to October, inclusive; and 1913 for entire year. In last column is given total discharge for different years for period covered by records. There is also mean of different months shown based on these records, with mean total discharge as determined by these records. Period for which we have record is rather short. There is but one year which gives winter flow, year 1913, which was a year of very low flow.

Records for 1902, 1903, 1911 and 1912 are records at May's Ranch, and these discharges would include amount of water carried by Bellamy Canal. Record for 1913 is discharge at Lake Hattie Inlet Station with flow of Bellamy Canal added. Record for 1913 was furnished by Mr. Meeker. Bellany Canal is ditch diverting water from Little Laramie River into James Lake Reservoir. In addition to Bellamy Canal, Lake James also has diversion ditch which head on North Fork of Little Laramie, commonly called Loback Canal and so indicated on map attached to answer of corporate defendants.

Hatton Station on Little Laramie is at lower end of Centennial Valley. Station is below Centennial Valley and practically at head of Little Laramie River Valley proper. In taking these
3469 measurements no effort has been made to account for diversions of water from Little Laramie River and tributaries in area known as Centennial Valley. I have not taken into account at all use of water in that valley. There are number of ditches diverting water from Little Laramie and tributaries in that valley. Any water consumed by these ditches, in irrigation of these lands, has to be added to measurement which I will give, if entire flow of Little Laramie River is to be taken into consideration. In other words, my record does not show diversions above Hatton Station.

Use of water from Little Laramie and tributaries in Centennial Valley in Wyoming is similar to diversion and use of water from Big Laramie River in Colorado above Boswell Station and at inter-state line, with exception of diversions by Sky Line and Divide or Sand Creek Canals. General character of irrigation in Centennial Valley and Laramie River Valley in Colorado is similar, that is, irrigation of tracts close to river and raising wild or mountain hay. Return waters reach river very quickly. General methods of irrigation are same. Cannot say what relative area irrigated in two places is, but would conjecture it is not very different, even as to area. In all records, I have not included these small mountain ditches, those in Colorado off-setting, as it were, those in Little Laramie River in Wyoming.

(Exhibit 131, offered in evidence.)

Tabulations shown on Exhibit 131, indicates average discharge for period covered of 93,370 acre feet for entire year. Four of
3470 these years are only partially complete and one year is complete. Year 1913, is year furnishing complete record, and was a very low flow.

Average discharge Little Laramie River shown by table April to October inclusive, omitting records such as we have for five winter months, is 86,828 acre feet. Years covered by these records in combination are considerably below normal. Year 1902 by Poudre records was 51 per cent. of normal. 1903 by Poudre records was 116 per cent. of normal. We have no records at Woods Landing or at other points on Big Laramie for these two years, and therefore we are forced to go to Poudre River for our percentages. Year 1911 by Woods Landing records was 72 per cent. of normal. 1912 was 104 per cent. of normal, and year 1913 was 51 per cent. of normal. These years in combination make 80 per cent. of normal.

Normal flow for period April to October inclusive, appears to be 108,535 acre feet and normal for entire year 120,600 acre feet.

It is well to make comparison between discharge at this station and at Boswell or Woods Landing on Big Laramie, so that we may have still further check on what is probably normal discharge of Little Laramie River at Hatton Station. Discharge at Boswell Station as normal has been given is 220,933 acre feet. With Little Laramie with a calculated normal of 120,600 acres feet, percentage of runoff of Little Laramie as compared with that of Big Laramie at Boswell would be 55 per cent. It would be about 61 per cent. of discharge at Boswell s ıı we exclude Sky Line and Divide Ditches. Boswell flow, exclusive of Sky Line and Divide Ditches, is 194,000 acre feet.

Winter discharge at Boswell's I have estimated during my investigations from examination of Cache la Poudre River on winter flow, to be 4,185 acre feet per month. 55 per cent. of this amount might well represent winter flow for Little Laramie River and dis-
3471 charge would be about 2400 acre feet per month, or 12,000 acre feet for winter months. This added to 108,535 acre feet, previously mentioned, would again give total discharge of 120,-535 acre feet for Little Laramie at Hatton.

That is arriving at total yearly runoff by two methods.

Fortunately we have records on both Big and Laramie rivers during same years, that is, during 1911, 1912 and 1913, and relative flow of two streams can be determined by comparing these years separately.

1911 records cover same period at same stations, Boswell's and Hatton, May to November inclusive. Heretofore we have directed our investigations to period April to October, for reason that was period more completely covered by records and is also irrigation period and period of larger flow. Again taking that portion of the year, assuming 8,100 acre feet as discharge for 1911 for Boswell station for April, and adding the discharge May to November, 112,-605 acre feet, and deducting November discharge, 3,709 acre feet, we have for discharge at Boswell's April to October, 1911, 117,046 acre feet, to which should be added Sky Line and Divide diversions of 23,503 acre feet, giving total at Boswell discharge of 140,549 acre feet. Comparing this with Hatton Station and adding April discharge of 6,900 acre feet to 62,790 acre feet recorded, we have total of 69,690 acre feet which is 50 per cent. of flow at Boswell. In 1912

records can be compared in similar manner with results. That year flow at Hatton was 55 per cent of that at Boswell's.

1912 discharge of Little Laramie at Hatton was 107,940 acre feet, May to October, inclusive. Estimate for April to October is
3472 113,590 acre feet. For Boswell's we have discharge for April to November 185,653 acre feet. Dropping discharge for November, 3,405 acre feet, and adding discharge of Sky Line and Divide Ditches, 23,143 acre feet, we have 205,189 acre feet, which figures show that discharge at Hatton was 55 per cent of that at Boswell.

1913 discharge at Hatton, April to November, was 55,004 acre feet; at Boswell's was 90,935 acre feet, to which should be added discharge of Sky Line and Divide Ditches 15,222 acre feet, giving total of 106,157 acre feet. The percentage indicated by these figures is that Hutton Station discharges 52 per cent. of that discharged at Boswell's Station.

Referring to 1912, discharge at Hatton, May to November, was 107,940 acre feet. Adding six months, which are missing, total would — about 128,000 acre feet. I have calculated that probable discharge at Hatton, based on records and on calculations which I detailed, is 120,700 acre feet per annum as an average or normal.

1912 on Little Laramie River was about 106 per cent. of normal as indicated from foregoing deductions.

Having now treated flow of Laramie River by records as shown at Boswell's, at Woods Landing and flow of Little Laramie River at Hatton Station, I will now discuss further supply of Laramie River below these stations.

One of the objects of presenting information in reference to flow at Woods Landing and at Hatton, was to ascertain
3473 what total amount of water is available for use in Laramie valley and amount which Colorado might divert. To ascertain total annual supply I have discussed somewhat at length duty of water on Poudre River at first with original water available for Poudre valley. Following that same thought, I will now take up total original supply available for Laramie Valley, influence of diversion of water by means of Greeley-Poudre System, and relative amounts of water which can be used by each.

From discussions of water supply at Hatton, Boswell's, and Woods Landing, it appears that waters available for use in irrigation are as follows:

Woods Landing station, 250,500 acre feet, Big Laramie River.

Hatton Station, 120,700 acre feet, Little Laramie River.

Discharge at Woods Landing does not include run-off from area of which Fox Creek is principal stream, area lying between Woods Landing Station and vicinity of Pioneer Dam. This area is 36 square miles, and I have estimated runoff of that area to be 400 acre feet per square mile per annum, or 14,400 acre feet. I was influenced somewhat in this conclusion by study of statement by R. I. Meeker with reference to amount of water which entered Laramie River between Woods Landing Station and Pioneer Dam for month of June. I believe his statement will show that there was 5,871 acre

feet net entered river between these two stations in year 1912. Omitting territory drained by Shell Creek, Antelope Creek, Sand Creek and that area drained directly into the Laramie River from the territory west of Laramie, which we might call Big Hollow country, and that portion of drainage area in Laramie Plains proper outside of mountain area, total supply is 385,600 acre feet.

3474 Total available supply above Wheatland Reservoir No. 2 must include, besides this figure, the runoff from mountain territory at the head of Four Mile, Seven Mile, Cooper and other small streams, heading in mountains north of Little Laramie River on West side of valley. The mountain territory, excluding plains country, is about 60 square miles in extent, or 38,400 acres. On a basis of 1/3 acre foot per annum, yield of this territory would be 12,800 acre feet. Mountain area on each side of Laramie Plains should also be included. Mountain area lying south of point opposite Two Rivers and opposite Wheatland Reservoir. This mountain area is about 60 miles in length and 5 miles in width on average. I have assumed, however, the area to be only 3 miles outside of valley itself. On basis of 1/9 of an acre foot runoff on entire drainage area, yield from this area would be 12,800 acre feet. Some waters enter river from plains area proper. This area is very extensive and in neighborhood of 600,000 acres. Waters which reach river, however, from this area, I think come almost entirely from violent storms or cloudbursts. It is erratic in character, so often of considerable volume. I have not, however, included any runoff in my table for this area.

411,200 acre feet total available water supply of Laramie River above Wheatland Reservoir. This is obtained by adding 12,800 acre feet from the westerly mountain area, and 12,800 acre feet from the easterly to the 386,600 acre feet above mentioned.

Below Wheatland Reservoir No. 2 there is water entering river from tributary streams from mountain area lying principally to north of Laramie River. Of necessity there is a certain amount of water wasted, or which accidentally passes diversion dam of

3475 Wheatland system at tunnel from Laramie River into Blue Grass, and on account of such waste, I have not included inflow into river in that portion of stream.

411,200 acre feet is approximate available water supply of Laramie River and tributaries at tunnel of Wheatland system for use of Laramie Plains country and Wheatland territory. There is also available to the Wheatland project the flow of the Blue Grass and Sybille Creeks. 1913 flow of Sybille Creek for period April to November 22 inclusive was 19,452 acre feet. Some of this water was probably waste or seepage from Wheatland colony, but in month of April discharge from table is shown to be 9,283 acre feet. This quantity was discharged before any water was run from Laramie River to Wheatland lands as shown by records at McGill Station. Apparently first water was diverted, other than that which leaked through valves at reservoirs, about May 3 to 5, so that considerable runoff exists in Sybille Creek itself, above inlet ditches to Wheatland system.

9,283 acre feet for month of April, 1912, for Sybille Creek was

taken near mouth of the stream. Data was furnished me by State Engineer of Wyoming. We might say this entire amount of water was discharged from Blue Grass and Sybille Creek and not from any waste and return waters from Wheatland system.

15,000 acre feet in the year 1913 was probably furnished by the Sybille drainage, exclusive of waste and seepage. This year, 1913, has been previously remarked as being the year of quite low flow, and I think it is safe to assume that the amount of water furnished by Sybille and Blue Grass Creeks would be about 20,000 acre feet per annum on the average.

3476 Total available water supply for the Laramie Plains area and the Wheatland area, exclusive of Sand Creek is 430,692 acre feet. Including Sand Creek flow of 17,000 acre feet, there would be 447,692 acre feet.

Some other water was available for lower Laramie Valley, furnished by the North Laramie and by Chugwater Creek, and other smaller streams entering river below Wheeler bridge in vicinity of town of Wheatland. These need not be considered, first, because they are not available for lands of Wheatland colony, nor for lands of Laramie Plains proper; second, they are required to a very large extent to irrigate lands bordering them. From reports published by State Engineer of Wyoming for years 1911 and 1912, discharge of Chugwater Creek, near mouth of stream, was 18,300 acre feet.

Area irrigated from Laramie River and tributaries below mouth of cañon north of Wheatland, or broadly speaking, area along the Laramie River lying below Wheatland and down to the mouth of the Laramie River, is not extensive. A small but constant supply is about all that is necessary. Natural flow of North Laramie and Chugwater, together with return seepage, will without question supply these lands, so that, considering water supply, we need not consider Chugwater nor North Laramie, nor lands on these streams nor on main stream below Wheatland.

Such a treatment as this simplifies discussion.

We have as result of this analysis nearly one-half million acre feet of water for use by Colorado and Wyoming. Of this supply, 447,692 acre feet, Colorado will take at most 91,000 acre feet, or one-fifth of total supply.

91,000 acre feet is amount of water taken from Laramie River by Sky Line Ditch, Sand Creek or Divide Canal, and the Greeley-

3477 Poudre tunnel and its collection ditches as now partly constructed and also the amount which would be available if projection of West Side Ditch were made around to the McIntyre Creek. If we were to exclude Sand Creek supply, however, on one hand, and improbable development on lower McIntyre, relative total supply to be used by Colorado would be as 432,692 is to 76,000, about one-sixth of the water would be used by Colorado.

When I said 411,200 acre feet would be available to the Wheatland works, I neglected to state that amount included diversion by Sky Line and Sand Creek Ditch from Laramie River. Not only that, that figure is not intended to represent amount which actually passes Wheatland tunnel. It represents amount of water which enters area

known as Laramie Plains and is available for use on Laramie Plains and Wheatland area. Considerable part of this water is of course used on both Big and Little Laramies above Two Rivers Station and above Wheatland Reservoir. A very considerable amount of which is wasted and evaporated, but it represents what I term "original water" which is available for use and, with the information of how much original water is available, we can now make something of an estimate of area which it is capable of serving.

Colorado furnishes from the Laramie drainage 237,500 acre feet annually. Sand Creek furnishes to Wyoming 17,000 acre feet annually, making total from Laramie River drainage in Colorado flowing into Wyoming 254,500 acre feet. Colorado furnishes over 50 per cent. of total supply.

3478 A gauging station was maintained at Uva, located immediately below junction of Laramie River and North Laramie. This station was maintained by United States Geological Survey in cooperation with state of Wyoming. These records were kept for years 1895, 1896, 1897, 1898, 1899, and 1903. Average annual discharge as shown by these records, or rather mean discharge for those years was 174,086 acre feet per annum. Below that point there is very little irrigation from Laramie River. Stream flows through rough country. Valley is very narrow. There are small areas adjacent to river which can be cultivated. There is also some land at mouth of Laramie River which is irrigated. But aggregate is not very great. I think a few thousand acres will probably cover total of land below Uva and below practically all irrigated section of Laramie River drainage.

Referring to main Laramie River in Colorado inflow between Glendevey and Boswell Stations is considerable. Principal tributary of Big Laramie outside of Little Laramie is McIntyre Creek, which flows into Big Laramie River from west between these two points. From east side there is Jimmy Creek and on west side there is Stuck Creek, Grace Creek, Laramie, La Garde Creek, and other small

3479 streams. These are all good sized creeks. The inflow on McIntyre Creek alone is more than one-third of flow at Glendevy station on Laramie River. Total inflow between Glendevy Station and Boswell Station is about one-half or more of the total flow which appears at Boswell Station. This statement is made in connection with reasons for discarding records at Decker Station, and as criticism of those records, showing their unreliability. On these creeks which I have described as entering river between Glendevy and Boswell Station, there is no diversion by any of these inter-mountain streams, with exception of two mile area at upper end of McIntyre Creek, which I have mentioned. Greeley-Poudre System in this one respect, cannot interfere with that flow whatever.

Accurate conclusion of normal flow of a stream cannot be obtained from a record of only two years, unless you have other data on adjecent streams. In absence of records from adjacent streams, it would be of some value, to be sure, but it would be very unreliable.

In seeking to ascertain water supply on a stream, we use every effort to extend period of records as far as psosible, and as a last

resort, we consult weather records. Flow of stream does not follow very closely matter of precipation, but where records are as short as two years, weather records do become of value as indicating whether two years have been above, below, or somewhat near normal. But taking two years' records of themselves, it would be very risky to assume that they would give an average. It would be an accident or coincidence if they did happen to give an average of the real true normal.

3480 Mr. R. I. Meeker took factions of two years, 1912 and 1913, and sought to derive a table of means. I have taken all records that I could find on Laramie River itself and have also examined data on adjacent watersheds, so that my information might cover as many years as possible.

The mean of which I speak is contained on several exhibits, of which Plaintiff's Exhibit "I" is typical. That table was prepared by Mr. Meeker.

Mr. Meeker considered year 1912 as one of abnormally high flow. I have previously stated that year was approximately normal in its discharge. Flow for May, June and July was above normal, while the flow for winter months is shown to be quite a good deal below normal, with result that year as a whole is approximately normal. The impression that this was an abnormally large year, was doubtless derived from fact that in month of June, there was some very high water for a few days. Even this high water was by no means as large as had previously occurred. In year 1897 water was higher in both months of May and June. In 1899 water was higher in May and June. In 1900 there were dates in both May and June when water was higher than at any time in May and June, or at any time in 1912. The published records of United States Geological Survey for 1897 show discharge on May 25 of 3,400 cubic feet per second, some 900 feet more than the highest record at Boswell's in

3481 1912. In 1899 on June 25 records of Geological Survey show discharge of 4,502 cubic feet for that day, and for a considerable period a discharge in excess of 3,000 cubic feet per second, as against maximum at Boswell's in 1912 of 2,570 cubic feet per second, so that as stated, these conditions even with large floods, are not unprecedented or abnormal.

I have taken into consideration amount of water stored on Laramie Plains region during seasons 1911, 1912 and 1913, more particularly with respect to storage in James Lake, Lake Hattie, and Wheatland Reservoir, as given by witnesses for state of Wyoming in this case. I have examined supply and use for those years, particularly of 1912 and 1913, *on* which years records are more complete, and I have constructed maps to show conditions of those two years. Those two years being particularly interesting from fact that in 1912, was so nearly normal run-off, while 1913 was a year of very low flow.

An examination of these conditions in 1912, of use, storage and flow, would give one very good idea of what would obtain during normal and ordinary years, while examination of use, supply, storage, etc., in 1913, would give one very good idea of whether there

was sufficient water in year of extremely low flow, or whether there was insufficiency of water in such years. With reference to 1912, it would indicate whether there was a surplus of water in such a year, and it was for this reason that I made a particular study of these two years.

I first considered in examination of 1912 conditions, amount of water which was stored, particularly amount of water which
3482 was held over from year 1912 to year 1913, and in which had there been a shortage in 1913, this water stored and held over from 1912 would have been available for use.

I wish to recall briefly some figures and evidence previously submitted in this case, and then take up analysis of those figures.

Capacity James Lake has been stated as 41,100 acre feet. The area has been stated as 1,370 acres at high water line, with a storage depth of 30 feet. Mr. Z. E. Sevison, one of witnesses for Wyoming, makes following statements in different parts of his testimony:

"There was 22,000 acre feet stored in James Lake in 1912; 18,000 acre feet in 1909; 10,000 acre feet in 1910; 10,000 acre feet in 1911; and 3,000 acre feet to March, 1913."

Mr. Meeker, witness for Wyoming, makes following statements in his testimony or on Exhibits which were prepared and presented by him; That there was diverted by Bellamy Canal for use in that canal and James Lake in 1912, 24,793 acre feet, and in 1913, 12,310 acre feet.

There was stored in James Lake in 1912, 22,000 acre feet and 24,793 acre feet diverted, which would seem to indicate that Bellamy Canal used 2,793 acre feet.

On Plaintiff's Exhibit "K", I find following statements: July 17, 1912, in storage in James Lake 15,000 acre feet; November 25, 18,400 acre feet; April 25, 1913, 20,400 acre feet; October 30, 19,800 acre feet.

Mr. Sevison states that there was no water carried over from 1911 to 1912, and entire storage was used in 1911, so that deducting the amount in storage November 25, 1912, as stated by Mr. Meeker, of 18,400 acre feet, from diversion made in 1912, we have left 6,393 acre feet, exact use of which is not determinable from evidence,
but which was in all probability used by Bellamy Canal or
3483 lost by evaporation from surface of James Lake.

It appears, therefore, in this practically normal year of 1912, there was an excess of water not only available for James Lake system, but there was actually stored in year 1912, over and above all uses, 18,400 acre feet. No water was held over from 1910 to 1911 in Wheatland Reservoir No. 2, according to testimony of Mr. Elliott, one of witnesses for plaintiff, and none in the reservoir at end of 1911.

119,770 acre feet was flow at Lookout May 27, to December 31, 1912, according to testimony of Mr. Meeker, as shown by his exhibits. Flow past Lookout prior to May 27, must have been considerable, as high water in river begins prior to that date, and I have assumed that flow through the reservoir prior to that date was 6,000 acre feet. Mr. Meeker also states that on May 27, 1912, there were

36,600 acre feet in the Wheatland No. 2 Reservoir. The 6,000 which I have estimated, is in addition to this 36,600 acre feet.

162,370 acre feet went into or through the Wheatland Nos. 2 Reservoir in 1912. 95,653 acre feet were withdrawn from reservoir in 1912, as shown by records at McGill Station, which station is just below outlet of Wheatland No. 2 Reservoir. I have been informed that at one time in month of April in 1912, there was as much as 600 cubic feet per second of time being discharged from this reservoir. We have no records which will show what amount of discharge prior to the McGill record was. I have assumed it was 6,000 acre feet, though in all probability it was considerably more than that, so that total withdrawn from reservoir in this year, if my assumption is correct, was 101,653 acre feet. Subtracting amount withdrawn from reservoir from that which passed into or
3484 through reservoir in 1912, we have 60,718 acre feet. While Mr. Meeker in his Exhibit "K" states that on November 18, 1912, there was 43,000 acre feet left in reservoir, after November 18, inflow in 1912 for December was 3,140 acre feet, and for portion of the months of November from 18 to 30 was 2,400 acre feet, which would indicate a total in reservoir on January 1, 1913, of 48,540 acre feet.

There was loss in this reservoir by evaporation in 1912. I have taken this evaporation as 13,717 acre feet, leaving in reservoir, in round numbers, 47,000 acre feet. Between November 18 and January 1, 1913, some water was doubtless lost by evaporation and escape. If we assume this loss to have been 1,540 acre feet, estimate which I have made and that of Mr. Meeker would be made to conform exactly and would indicate loss from evaporation during 1912 of a little over 15,000 acre feet.

The figures are further confirmed by statement of Mr. Elliott, to effect that at end of season of 1912 there were 40,000 acre feet in this reservoir. Inflow for October, November and December, 1912, was 19,070 acre feet, and outflow was 463 acre feet, leaving amount which should be in reservoir 58,607 acre feet. This indicates a discrepancy between figures given by Mr. Meeker and those given by Mr. Elliott of about 10,000, after allowing for any evaporation, and may be due to erroneous estimates in capacity of reservoir between different contours or in assumption of capacity of reservoir itself.

There is considerable discrepancy in the evidence presented by plaintiffs as to capacity of this reservoir. Mr. Meeker assumes an active capacity of 83,500 acre feet. Mr. Elliot's statement
3485 was, I think, to the effect that capacity was 120,000 acre feet, and Mr. Johnson stated that capacity was 126,000 acre feet. No accurate survey, I believe, has been made of this reservoir, and so far as I know, there is no accurate or authentic record of its capacity.

I have taken the lesser figure of 47,000 as the amount in storage December 31, 1912. The inflow for year 1913 at Lookout Station, is given on records for that station as 78,678 acre feet. In 1913, therefore, total amount of water in or passing through the reservoir was 125,678 acre feet. Of outflow as given by McGill Station record

was 96,318 acre feet, leaving an apparent net remaining in reservoir at end of 1913, of 29,360 acre feet. Evaporation for that year should be deducted. I have taken this evaporation as 15,000, which would leave 14,300 acre feet in reservoir. This figure is confirmed by the figures and statements presented by Mr. Meeker to effect that on November 20, 1913, there were 9,000 acre feet in reservoir. After that date inflow for November was 1,650 acre feet, and for December 3,997 acre feet, and outflow was 123 acre feet, leaving in reservoir on January 1, 1914, 14,524 acre feet, a quantity almost identical with that calculated by the other method.

Mr. Elliot states that in 1912 Wheatland project used 100,000 acre feet. 95,653 acre feet appears to have come from the reservoir during the period of which we have record. The balance may have come from Blue Grass and Sybille Creeks, or may have come from reservoir prior to May 27th. Mr. Elliott is an engineer and at time of his testimony was superintendent of this Wheatland system.

3486 Mr. Johnston, to whom I have referred as stating capacity of this reservoir was 126,000 acre feet, was manager of Wheatland project for many years.

Mr. Meeker was employed by Laramie Water Company, which company is sometimes called the Lake Hattie Company, and is the owner of Lake Hattie system, at times he was making these measurements, and calculations which resulted in his conclusion that there were 83,000 acre feet in the reservoir capacity.

Wheatland No. 1 Reservoir, according to Exhibit K, appears to have stored in 1912, 10,500 acre feet, and on November 20, 1913, there was left in reservoir 2,100 acre feet, showing use in 1913 of 8,400 acre feet, over and above any water which might have been stored in reservoir during year 1913.

On Lake Hattie Reservoir an active capacity is stated as 68,500 acre feet; depth is 28 feet. Area is 2,443 acres and storage capacity at 20 foot depth is 30,000 acre feet. Unavailable or dead capacity was stated as 42,000 acre feet. Statement is also made that water was available above the dead space in June, 1912, also that there was between 10 and 11 feet depth of water available above the floor of outlet in middle of July, 1912. Mr. Bishop, one of witnesses for plaintiff, stated that amount available from Little Laramie River was 20,000 acre feet. Mr. Meeker, in his exhibit, states that amount from Little Laramie River was 14,053 acre feet. Mr. Meeker's statement was based on measurements and seems proper to take that figure. Mr. Meeker also states that water discharged into this lake from Big Laramie River was 69,855 acre feet. Total received by reservoir from both the Big and Little Laramies was 83,908

3487 acre feet. Mr. Meeker also states on one of his Exhibits that on November 20, 1912, amount of water in the reservoir was 18,700 acre feet. The difference between amount in reservoir on November 20, 1912, and statements in reference to inflow for that year, is 83,908 acre feet, minus 18,700 or 65,208 acre feet. The dead capacity, therefore, instead of being 42,000 acre feet, would be 65,208 acre —, less whatever amount might have been lost

through evaporation and seepage. With an area of 2,443 acres and with reservoir only partially filled, and for portion of year between June and November 20th, allowing for evaporation 3,208 acre feet, the dead capacity would appear to be 62,000 acre feet, and total amount stored in 1912 both available and unavailable would be 80,700 acre feet.

April 24, 1913 there was 19,400 acre feet in Lake Hattie Reservoir according to plaintiffs' Exhibit "K." Inflow from Big Laramie River in 1913 was 28,470 acre feet. I am informed there was no inflow from Little Laramie in this year. Total in lake, therefore, exclusive from any losses from evaporation, would be 47,870 acre feet of available water. It is stated, however, that on November 5, 1913, there was 26,000 acre feet in reservoir. It thus appears, that 21,870 acre feet was used, lost through evaporation, seepage, etc., of which possibly 5,000 acre feet is due to evaporation and 16,870 feet was discharged from reservoir. It appears, therefore, that in very short year of 1913, after using or discharging from reservoir 16,870 acre feet, this company succeeded in increasing storage in Lake Hattie 7,300 acre feet without taking any water whatever from Little Laramie River.

3488 Testimony in-duced in behalf of Plaintiff shows Lake Hattie having total capacity of 110,000 acre feet, of which 42,000 acre feet was dead water, that is, water which could not be withdrawn under present system of outlets. I have assumed a larger dead capacity in my calculation. I do not reduce active capacity in accordance with amount which I have increased dead capacity. I arrived at that dead capacity by taking inflow into reservoir up to a certain date, on which date positive statement was made that there was certain amount of water in reservoir. Subtracting inflow during that period from amount so stated as being in reservoir, I thus obtained dead capacity.

By Mr. Delph E. Carpenter:

You are to understand that in abnormally low year of 1913, the Laramie Water Company actually diverted into Lake Hattie Reservoir 28,470 acre feet of water from Big Laramie River. I summarized amount stored in 1912 as follows:

Lake aJmes, 18,400; in Wheatland No. 2, 47,000; in Wheatland No. 1, 10,500; in Lake Hattie, above dead space, active capacity, 80,700; total, 156,600.

156,600 acre feet is amount stored in 1912 in excess of use in that year.

By Mr. Fred Farrar:

In other words, the figure last given represents amount of water left over rather than amount stored. Furthermore, records at Wheeler Bridge for 1912, indicate that there were 10,000 acre feet that passed that point in 1912. As 1912 was year of larger flow than 1913, and as in 1913 there were over 19,000 acre feet of water discharged by Sybille Creek, discharge of that creek in 1912 was certainly as much as 20,000 acre feet. Chugwater Creek in 1912

furnished 18,300 acre feet, as stated. Adding these amounts to amounts left in reservoirs, together with 600 acre feet, which
3489 was probably wasted before May 27th, total remaining in storage and available for use in 1913 and that wasted, is 210,900 acre feet, after allowing 16,825 acre feet for evaporation in the reservoirs.

Water used during this year, 1912, by Wheatland project was stated to be 100,000 acre feet. There were 6,390 acre feet either used or evaporated in James Lake system, and there was used 17,703 acre feet in the Pioneer Canal.

These amounts, added to that held over in storage and wasted, show storage, waste, and use of 341,000 acre feet, or, excluding amount used in Pioneer Canal, 323,303 acre feet, being amount of water for which we have account for this year exclusive of all use of water on Little Laramie River and on Big Laramie River on Laramie Plains.

Amount of water used on Little and Big Laramies I could not obtain except by subtraction. On Plaintiffs' Exhibit J, it is stated that there was used between Number 2 Dam and Two Rivers, 17,245 acre feet. But the testimony also shows that there was nearly 30,000 acres irrigated and use and duty on Little Laramie River of only .6 of an acre foot per acre, which is ridiculous on its face. The evaporation from the surface of the soil alone, to say nothing of transpiration by the plans, would exceed that amount. Meadow lands of Little Laramie River Valley are continuously wet. Evaporation would be very great.

Evaporation from water surface in this valley would amount to 5 or 6 acre feet per annum. Mr. Meeker, witness for Plaintiff, stated that in his opinion it would be 6 acre feet per annum of water surface exposed.

Authorities, study and experiments indicate evaporation from wet soil is greater than that from water surface, so that from this
3490 30,000 acres in Little Laramie Valley, there would be a much greater exaporation than the use shown by these figures.

Same reasoning will apply to Exhibit J for 1913. Mr. Meeker also shows use between Pioneer Dam and Two Rivers to be 29,892 acre feet. On Plaintiff's Exhibit L, there were some 38,000 acres said to have been irrigated in this section.

Duty of water therefore would be considerable less than an acre foot per acre.

Similarly, in 1913, use of water between Pioneer Dam and Two Rivers is stated as 18,917 acre feet, a use of a little over one-half acre foot per acre. This would indicate to my mind that amount stated as passing Pioneer Dam was very much too small. The amount allowed for use between and below that point is entirely inconsistent with amount of acreage claimed to have been irrigated.

Amount indicated by this use is only a fraction of that claimed to be the duty of water on that section. Have forgotten just what the testimony was relative to the duty of water, but assuming it to have been 2½ acre feet per acre, this figure as given would only amount to 1/5 of the actual duty.

Assuming that Mr. Meeker's calculation as to duty of water is correct, it would then be evident that Wyoming has sufficient water to irrigate nearly one million acres.

There might be an explanation advanced for this remarkable array of figures as presented on Exhibits J and L, by the statement that there was considerable inflow into the river between
3491 Pioneer Dam and Two Rivers. In that case, and if such a reason should be advanced, I would have to revise my figures and allow a very much greater inflow between these points than I have allowed. In other words, I would have to allow a larger amount for total supply than I have.

Law of Wyoming permits maximum diversion of 1 cubic foot per second for every 70 acres of land irrigated. Testimony shows that in 1912 100,000 acre feet of water was used on the Wheatland area. Testimony also shows that there was under cultivation an irrigated area in Wheatland tract 31,050 acres of land, including 1,050 acres in Bordeaux tract. If total maximum diversion of 1 cubic foot per second for 70 acres of land were allowed for this 31,050 acres for a season of 90 days, with a diversion to the maximum amount for the entire time, there would only be required, 79,848 acre feet of water for the Wheatland tract. It should be stated, however, in order not to be misled, that use and requirements for a large part of this period of 90 days is much less than this maximum. 90 days' actual irrigation is more than is required on Wheatland tract.

20,000 acre feet in excess of legal maximum allowed by Wyoming law was used by Wheatland project in 1912. If irrigation was
3492 less than 90 days the excess would be still greater. If 1 cubic foot per second of time for each 70 acres of land was more than is reasonably necessary for proper irrigation, then excess would be corresponding. I think an even greater difference is due to the fact that the maximum is required for only a small portion of the 90 days. Maximum demand in Wheatland district would come in month of June and early July. Demand and necessity would decrease after July 1st and it would not be so great prior to June 1st. Maximum as fixed by Wyoming law, as I understand it, is intended to meet even extraordinary conditions, and to meet demand during that period called by engineers the period of peak load, and it is not intended to represent at all the average amount which may be diverted, but rather the maximum which may be diverted to meet the peak load. From evidence introduced relative to irrigation season in Wheatland district and necessity and duty of water, would say that the peak load would probably require that entire area of Wheatland district be covered once, be irrigated once during a period of three weeks in latter part of June and first of July. I believe peak load would not last more than 21 days out of the 90 and that average would be 70 per cent. of peak load, possibly 75 per cent., which would indicate a requirement for the district of 60,000 acre feet, instead of 100,000 acre acre feet, as diverted in 1912.

3493 Examination by Mr. Delph E. Carpenter:

Dead space constitutes following factor in the irrigation development of a community. During first few years of operation on an irrigation project, there is what might be called a period of initial expense. It occupies same position on irrigation projects as initial expense of any enterprise. On irrigation enterprises, initial expense as regards water is amount of water lost in putting system in operation. On Lake Hattie, for instance, there was an initial expense of water in filling dead space. Before reservoir could be operated, of necessity unavailable capacity must be filled. After this unavailable capacity is once filled, it does not have to be filled again, water in unavailable capacity remaining from year to year, so that first year, or first two years, this Lake Hattie was in operation, there existed necessity of drawing from the river an amount of water sufficient to fill dead space, that is, to meet this initial expense of water. Same is true as regards canals. There is an initial expense in operation of new canals; generaly speaking, when canals are new, loss from seepage is very much greater than it is later. If canal is properly constructed, soil on bottom and sides of ditch will become
3494 silted and tighter and less water will be lost by seepage. In year 1912, 62,000 acre feet of dead capacity filled in Lake Hattie reservoir was an initial expense.

This filling of the dead space or initial expense should not be considered as a necessary continuing requirement. When this expense is met once, it is practically eliminated for all time. There is, to be sure, a loss from evaporation from surface of unavailable water, on account of area exposed to times when available capacity of reservoir has been exhausted. That loss of course will be continued and yearly.

It is hardly proper to view operations in 1912, without due consideration of the unavailable capacity of Lake Hattie having been filled during that year. Had that system been in operation for a few years more than it has been, 1912 being, for all practical purposes, first year when reservoir was used, this initial expense would have been previously met, and, if amount of water which was discharged into reservoir in 1912 from Big and Little Laramie Rivers had not been in part consumed in filling this unavailable capacity, reservoir would have been entirely filled during that year and some 12,800 acre feet would have passed over the spillway or been discharged through the outlet gates. This water would have remained in the river for other appropriators.

3495 For purposes of consideration of available flow of Laramie River in connection with Lake Hattie for 1912, total diversion of water into the Lake during that year should be considered as active and available water.

To give an idea of amount of water required to meet this initial expense of water in filling dead or unavailable space in Lake Hattie in 1912, I will state that 62,000 acre feet of water required to fill this space would have served about 62,000 acres of land in the Cache la Poudre Valley in Colorado, if the return seepage is counted. As

direct appropriation, and without regard to use of return water, it would have served 50,000 acres in that valley; for instance, it would have been sufficient to serve 50,000 of the 125,000 acres of the Greeley-Poudre Irrigation District. Assuming a duty of 1.25 acre feet per acre per annum under Water Supply and Storage Company's System in Poudre Valley, this amount of water would have been sufficient to more than irrigate entire tract under the Larimer County Ditch, namely, 45,000 to 50,000 acres.

This dead space should be eliminated from all future consideration of water supply and demands of Big and Little Laramie Rivers, in so far as the Lake Hattie system is concerned, for reason that it is now filled and will never again have to be filled. There is also some dead space in the Wheatland No. 2 Reservoir, but this was filled prior to 1912.

3496 In figuring capacities of various reservoirs, it has been custom to figure available capacity, rather than total capacity, including available and dead space. This available capacity is termed active capacity. It is the useful part of reservoir and that is part of reservoir with which we have to deal and on which we base irrigation project.

Same initial expense had probably been supplied in 1911 and 1912 within James Lake. It is a natural lake, in which unavailable capacity has been filled from time to time by natural flow of Seven Mile Creek.

Have adopted another method of illustration by which I demonstrate conditions prevailing in Laramie River and tributaries during 1912 with regard to water supply. Have prepared diagrams which illustrate and which perhaps will give clearer idea of conditions on Laramie River in 1912 and 1913 than by mere presentation of a mass of figures. These diagrams are called hydrographs and there is one set pertaining to each of years, 1912 and 1913. There is still another one pertaining to the normal at state line.

Referring to 1912, I constructed hydrograph showing water supply in Laramie River to Woods Landing, showing amount diverted by Sky Line and Divide Canals and inflow between head of river and other points such as tunnel and collection ditches, amount between Glendev-y and Boswell's and amount between Boswell's and Woods Landing.

3498 (Defendants' Exhibit 132, a hydrograph, offered in evidence.)

Defendants' Exhibit 132, is technically called a mass diagram and represents amount of water flowing past certain points on Laramie River for different months in year 1912. Outer line represents volume of water passing Woods Landing, including amount diverted by Sky Line and Divide Ditches. Amount of water flowing for any month can be read by reference to scale on left side of plat. Area cross-hatched at bottom of plat, this hatching being from upper left hand corner to lower right hand corner, and designated in legend as Sky Line and Divide diversions, is amount of water which in that year was diverted by Sky Line and Divide Ditches, limits

of this cross-hatched area representing amount diverted during months of June, July, August, Sebtember, October and November. Next above this area is cross-hatched in a diagonal, but in opposite direction as shown in legend, and this area represents amount of water which after Sky Line and Divide diversions have taken place, would be available for tunnel through flow of East and West Forks and delivered to tunnel by collection ditches. Area immediately above this, cross-hatching being horizontal, represents amount of water which enters river between tunnel and Boswell Station. There is something of a coincidence in the flow at G-endevy and that delivered at tunnel. Upper boundary of area representing flow at tunnel and collection ditches being almost coincident with lower boundary line area representing discharge between Glendevy and Boswell's.

3499 There is some water, however, passing Glendevy Station which cannot be taken into the tunnel by collection ditches. This diagram does not show that. The insertion of this difference would complicate the diagram so it would not be so readily understood and I therefore omitted attempt to show details. That part indicating an inflow between tunnel and Boswell's Ranch includes, in fact, some water passing Glendevy Station from drainage above. Area at top of diagram represented by vertical hatching is inflow between Boswell's and Woods Landing. Total of all these areas representing what might be termed natural flow past Woods Landing Station.

Diversions do not appear for Sky Line Canal for month of May during that year for reason that records of discharge of Sky Line and Divide Ditches for year 1912 show that there was but 285 acre feet diverted during that month. This is quantity so small that it cannot readily be seen on diagram, but column marked "May" upon close examination, it will be observed, that there is blue line at bottom of column, indicating this small quantity of 285 acre feet. Space between this blue line and bottom of graph can be seen if you look very close, there seem to be some little dots below horizontal line, these dots are beginning of diagonal lines such as are show- in months of June, July, and August. Owing to the small scale on which the graph was prepared, it was very hard to observe this small amount for that month. I have no record of any diversions

3499 by these canals during April in this or previous years. I have obtained the records from The Water Supply and Storage Company and have checked it by reports of the Water Commissioner.

(Defendants' Exhibit 133, a hydrograph, offered in evidence.)

Defendants' Exhibit 133, shows discharge of Little Laramie River and amount of water used and diverted by several ditches and amount of water passing different gauging stations on river. Diagram is similar to Exhibit 132, except that it is on different scale. On Exhibit 132, point representing 100,000 acre feet is the same as point representing 50,000 acre feet on Exhibit 133. I make this statement so that there will be no confusion in assuming that these

graphs are on same scale. It was necessary to make it on different scale in order to keep graph on sheet.

Area hatched in diagonal direction and at top of diagram for each month as shown by legend, represents amount of water diverted by Bellamy and other canals above Lake Hattie Inlet. This water went to James Lake and other projects. The area hatched by horizontal lines represents water which was taken into Lake Hattie Inlet Canal from Little Laramie River which water was discharged into
3500 Lake Hattie in 1912. Area hatched by vertical lines represents amount of water remaining after deducting diversions of Bellamy and Lake Hattie Inlet Canals, and also amount of water which appeared at Two River Station at mouth of Little Laramie. This difference represented by area on diagram between area representing Two River's discharges and that representing Lake Hattie Inlet discharge, would be loss or use between Lake Hattie Inlet and Two River's Station. If there are any errors in measurement at Two Rivers, Lake Hattie Inlet and Bellamy Canal quantities, it will be reflected in this area. I refer to area marked "loss and use between Lake Hattie and Two Rivers," that representing difference between total supply and that which has been or can be accounted for. Area at bottom of diagram represented by diagonal hatched lines, as shown on legend, represents amount of water which appeared at Two Rivers Station and was measured. Total column appearing for any one month, including several classes of cross-hatching, indicates total flow for that month at Hatton and Two Rivers Stations. It will be noted that diagram does not extend to include months of January, February and March. There were no records for those months. They were, therefore, necessarily omitted. Dash line appearing in columns for November and December represents upper boundary of area representing discharge of Little Laramie River at gauging station at head of Lake Hattie Inlet Canal. I didn't have Two Rivers Station designated on November and December columns. I had no records for those
3501 months at Two Rivers. That same dash line appears in month of April, being upper line of diagram of that month, in month of May, in month of June just above horizontal crossing, in month of July, August, September and October. Each instance represents same thing.

In both Exhibits 132 and 133, top of column represents maximum flow at any point, it is not necessarily at same station. Various classes of cross-hatching simply show distribution of total flow of month.

Defendants' Exhibit 134 is designated as a "Use Diagram, Laramie River, Two Rivers and Lookout, Wyoming." There is a gauging station at Two Rivers and at Lookout which is a point at head of Wheatland Reservoir No. 2. Exterior boundaries of this diagram represent maximum amount of water at one or other of these two stations. During some months in 1912 there was gain in river between these two points, and in other months there was loss. Assuming that gauging records and discharge records are correct, as

represented by witnesses for plaintiffs. Gain or loss is shown by cross-hatched areas. These areas are cross-hatched in opposite directions and as shown by legend. Larger areas represent use and loss between two stations, and this use or loss aggregated 12,000 acre feet. Gain is also shown aggregating 3,000 acre feet. Gain shows not necessarily total gain, but net gain between two stations.
3502 It is obtained by comparison of records of station at Two Rivers and that at Lookout. Scale of Exhibit 134 is on same scale as Exhibit 133. Scale is twice as large as on Exhibit 132.
In each of these graphs scale is shown on extreme left hand side.

(Defendants' Exhibit 134, a hydrograph, offered in evidence.)

Defendants' Exhibit 135 shows graphically condition of Wheatland Reservoir No. 2 for 1912, in so far as there are available records. This diagram was constructed almost entirely from data furnished by witnesses for plaintiff. Upper curved line represents combined flow of Big and Little Laramie Rivers at Two Rivers Station. Second line from top represents flow of Big Laramie River at Lookout station at head of Wheatland Reservoir. Both of these lines represent total amount discharged up to any given date. They do not represent flow at any period, but aggregate amount of flow up to any date. Third curved line marked "inflow less outtake" is obtained by subtracting outflow as recorded at McGill Station from inflow as recorded at Lookout Station. Blank area between second and third lines represents outflow or outtake. Cross-hatched
3503 area between first and second lines represents loss or use between Two Rivers Station and Lookout Station, or it may represent any errors in measurements at these stations. Bottom line designated as "quantity reported in reservoir R. I. Meeker" was plotted from data furnished by Mr. Meeker, Engineer for The Laramie Water Company, and if such data is correct, would represent amount of water remaining in reservoir as determined by observations of height of water in reservoir at different dates, and it is independent of either inflow or outflow data.

There is an inconsistency in position of last two lines, in that quantity reported by Mr. Meeker to middle of June was greater than amount reported by him as in reservoir May 27th, plus inflow between May 27th and middle of June.

In connection with this diagram I wish to call attention to fact that it was plotted on assumption that capacity of reservoir is 83,550 acre feet, which is capacity given by Mr. R. I. Meeker. The capacity, as I have intimated before, is an uncertain quantity. It is not definitely known. Amount of water in reservoir May 27th is also a quantity open to question and is not based on any definite or accurate knowledge of capacity of reservoir at different gauge heights. This figure, 36,600 acre feet, which marks initial points for plotting diagram, is amount of water stated by Mr. Meeker to have been in the reservoir May 27, 1912. If capacity of reservoir is in fact greater than 83,550 acre feet, as assumed by me, it would
3504 have effect of moving diagram as a whole upwards in vertical direction, which, in connection with flow of 1913, I have pre-

pared a similar diagram for Wheatland No. 2 Reservoir for that year, and that diagram illustrates change which would be made under such assumption. I have not made double diagram for 1912 for reason that it would be confusing.

(Defendants' Exhibit 135, a hydrograph, offered in evidence.)

Referring further to Exhibit 135, if capacity of reservoir is 120,000 or 126,000 acre feet, as has been testified by officers of the Wheatland Company, diagram would be changed very materially in its position on plat. There might be difference shown as much as 30,000 acre feet in reference to initial point of beginning of diagram. This diagram, as I have stated, was constructed almost entirely from data furnished by plaintiffs. For purpose of this graph, I have taken the active capacity of the Wheatland reservoir.

Defendants' Exhibit 136, is mass diagram showing in a different manner from graphs heretofore presented, flow of river for year 1912 at different points. It also shows use of water during that year, upper line on diagram representing supply and lower line
3505 representing use. Upper line was constructed by laying off on sheet acre feet on left hand margin and at bottom platting differences very approximately of several stations on Laramie River from Head of Laramie Valley in Colorado, Sky Line and Divide locations being three miles northerly from extreme upper end of valley. Glendevy Station is shown at about twelfth mile and represents its approximate distances from river. Similarly Boswell Station is shown at about thirty miles, Pioneer Dam as forty miles, Two Rivers as eighty miles, and Lookout Bridge as 100 miles. Distances are by no means accurate and represent relative rather than absolute distances, but for purposes of diagram answer purpose.

Upper line was constructed by starting with discharge of Sky Line and Divide Ditches, of 23,143 acre feet. Discharge or inflow at Glendevy Station, 76,150 acre feet were added to this amount, and discharge of Glendevy Station plus Sky Line Diversion was platted for Glendevy Station. Similarly inflow between Glendevy Station and Boswell, between Boswell and Woods Landing, between Woods Landing and Pioneer Dam, were also platted. Supply furnished by Little Laramie River as indicated by records at Hatton, were then added to supply as shown at Pioneer Dam and aggregate supply of Two streams, Big and Little Laramies were platted as all at Two Rivers Station. At station marked "Lookout Bridge," which is point at head of Wheatland Reservoir No. 2, I have added quantities which in my opinion represent something near inflow into river between Pioneer Dam and Lookout Station. Crediting Sand Creek with 17,000 acre feet, drainage area from east 12,800 acre feet, and drainage from west 12,800 acre feet, discharge for Sybille
3506 Creek for this year assumed at 20,000 acre feet, was then added to total, as was also discharge of Chugwater Creek, 20,000, with result that aggregate flow from all sources mentioned, exclusive of what might have drained into river from large area constituting Laramie Plains proper, amounts to about 480,000 acre feet. But, after having shown supply from Laramie River as repre-

sented by upper line, use of water was then taken into consideration and diagramed. This is shown on lower or second line. As supply of Sky Line and Divide Ditches was taken out at head of valley, that amount was deducted and after such deduction initial point of lower line was fixed at same station as previously used for Sky Line and Divide Ditches. Deduction was maintained, resulting in line parallel to first line until we reached Pioneer Dam. No diversions are shown between head of cañon and Pioneer Dam. As previously stated, these have been omitted in all cases.

When Pioneer Dam is reached, diversions occur at that point to Pioneer Canal and Lake Hattie. This diversion is represented by vertical line, and after this diversion, as well as that of Sky line, have been allowed for, we find we have left 159,989 acre feet. Now turning to Two Rivers Station we find from records for that station that amount which passed the station in 1912 in Big Laramie was
3507 126,068 acre feet. The difference between that and the 159,989 acre feet represents loss or use betwen two stations. This is according to records of two stations extended to cover entire year.

I allowed 69,855 acre feet diverted into Lake Hattie and 17,703 acre feet into Pioneer Canal proper. Those two amounts are indicated on vertical line immediately above words "Pioneer Dam" at head of bottom of plat. Loss or use was 33,921 acre feet. This amount does not include any inflow which might have come into river between two points. Actual loss or use between two points would of course include that amount. This figure, 33,921 acre feet represents amount of water passing Pioneer Dam, which was consumed before Two Rivers Station was reached and is shown on horizontal line marked "loss and use", 33,921 acre feet. It is difference between 159,989 and 126,068 acre feet. At this point in use curve, amount of inflow from Little Laramie River at Two Rivers amounting to 56,838 acre feet was added, showing available amount at that point after uses and losses mentioned have been deducted from total flow, 182,898 acre feet. Between Two Rivers and Lookout Bridge, there were losses, uses, and possibly some errors in that data. Net difference between Two Stations being 20,553 acre feet and amount 162,345 acre feet shown on plat for Lookout Bridge Station is amount passing that point for year 1912. As previously stated in my testimony, there is some loss from evaporation in Wheatland
3508 Reservoir No. 2 shown on plat at 14,092 acre feet.

There passed Wheeler Bridge, according to records, 10,000 acre feet. This would show use between McGill Station and Wheeler Bridge, disregarding any inflow between two points, of 128,253 acre feet. Below Wheeler Bridge Station Sybille Creek enters river in amount 20,000 acre feet. Also below Sybille Creek Station, Chugwater Creek discharges 20,000 acre feet into river.

This completes curve, showing use and disposition of water for year. Point showing amount after Chugwater Creek enters river is on line representing 20,000 to 50,000 acre feet. This 50,000 acre feet then being amount which passed down Laramie River below Chugwater Creek in this year, and, as far as Laramie Plains or Wheatland tract are concerned, is lost, and that amount or more, properly

speaking, represents amount of unused water below mouth of Chugwater Creek. The difference between this final point and final point on upper curve is about 430,000 acre feet. It represents use, loss, waste and stored amount for that season. On right side of plat I have caused to be placed vertical column showing different uses to which water was put. This column is derived from two curves previously described. Beginning at bottom of right hand column we find words "Wheeler Bridge loss." This is amount of unused water which passed that point. Just above these words we find "stored Wheatland No. 1." In year 1912 there was stored in Wheatland Reservoir No. 1, 10,500 acre feet.

Next notation reads "Stored Water Wheatland Reservoir No. 2." This portion of column is cross-hatched by diagonal lines, and represents amount of water remaining in storage in Wheatland Reservoir No. 2 at end of year 1912. Use of water by Wheatland district, excluding amount stored, is shown by vertical hatched portion of column and is marked "Use Wheatland" in amount about
3509 81,000 acre feet. Next notation reads "Loss in Wheatland Reservoir." This represents amount which was lost in Wheatland Reservoir by reason of evaporation. Last notation on right hand column reads "Loss and Use Two Rivers to Lookout," and represents loss and use between those two points.

After this point it was necessary to break column on account of inflow from Little Laramie River at Two Rivers. This break is same break noted on use graph at Two Rivers Station. Beginning with this second column first notation at bottom is marked "Loss and Use Pioneer to Two Rivers." This represents amount of water consumed by use or other losses between those two points. Above this is notation "Pioneer Canal." It represents amount diverted and used by that canal.

Next notation reads "Lake Hattie Dead Space Evaporation and Use." This represents amount of water which it took to fill dead space in Lake Hattie and supply any waste from evaporation in Lake. We have above these words the words "Net Left of Big Laramie." This is solidly covered blue area and represents amount of water which was taken from Big Laramie River for Lake Hattie, over and above necessary amount to fill dead space and to supply losses. The two areas, that hatched in a diagonal direction and that marked "Lake Hattie Dead Space Evaporation and Waste," and solid area marked "Net Left in Big Laramie" combined represents flow from Big Laramie into Lake Hattie.

Next notation reads "Sky Line Canal." This area represents quantity of water diverted by Sky Line and Divide Ditches.

Next notation is "Little Laramie to Lake Hattie" and this area represents amount of water diverted from Little Laramie to Lake Hattie.

3510 Next area marked "Bellamy Canal" and represents amount of water diverted into that canal and above that is amount supplied to James Lake. These two combined represent total diversion for year into Bellamy Canal, and part of which I have charged to use in Bellamy Canal and part to storage in James Lake.

Solid blue area opposite words "Discharge at Two Rivers" represents amount of water discharged at Two Rivers Station from Little Laramie and taken into connection with next area above marked "Loss and Use Lake Hattie to Two Rivers" represents amount of water which passed Lake Hattie Inlet Station on Little Laramie River Station.

Next area is marked "Use Between Dam and Two Rivers Additional." This represents estimated inflow from Sand Creek from drainage on east and drainage on west side of valley and discharge of Sybille Creek, as shown on next area and at top is graphically shown discharge at Chugwater Creek, the area being marked "Loss."

Scales indicating amount of water are same on columns and on graphs. Chart is based on records of 1912.

3511 A. V. OFFICER.

Direct examination by Mr. Delph E. Carpenter:

Manager of the Greeley, Eaton, Windsor and the Fort Collins factories of The Great Western Sugar Company. Manager of four factories since March 1, 1913. Originally located at Loveland from fall of 1900 until fall of 1907. Loveland factory was first constructed in northern Colorado territory. Was first manager of factory and promoted it. Located at Scotts Bluff, Neb. investigating territory August, 1908.

Thirteen years' experience in growing of sugar beets for manufacture of sugar. During that time have become familiar with business both from an agricultural and manufacturing standpoint in general way.

During time was at Scotts Bluff, Neb. had occasion to contract sugar beets at Wheatland, Wyoming. We undertook to develop that territory and tried it out as possible locality for sugar beet culture. At time of considering this territory in first in-
3512 stance, I made personal inspection of Wheatland area. My recollection is that was during summer of 1909, summer and fall, though it is very possible it might have been late winter of 1909.

1910 was our initial or experimental year in the actual growing of beets in Wheatland, Wyo. territory. Have been familiar with district and its returns since that time. Beets grown at Wheatland have always been worked at Fort Collins factory. Beets for first year, that were grown in 1910, were contracted for Scotts Bluffs factory. We were late in completion of the plant that year and in order not to delay harvest we diverted crop to Fort Collins. Beets grown at Wheatland during years 1911, 1912 and 1913 were shipped to Fort Collins factory for manufacture.

Tonnage of sugar beets harvested at Wheatland, Wyo. area during years 1910, 1911, 1912 and 1913 are as follows: 1910, 4235 tons; 1911, 3078 tons; 1912, 3073 tons and 1913, 3941 tons.

3513 Our first year, 1910, yield was less than it has been since. Conditions was probably due to a number of causes. My observation has been that first year growers are not always, in new

locality, really abreast of their work and planting may not be properly done.

Our records show the following for the Wheatland area:

1910, 1060 acres with average yield of 4.09 tons per acre;

1911, 338.6 acres with average yield of 9.09 tons per acre;

1912, 294.05 acres with average yield of 9.97 tons per acre;

1913, 535 acres with average yield of 7.6 tons per acre.

Am manager of Eaton Sugar Factory, among others. Yield of Eaton factory in tons per acre is as follows:

1911, average yield per acre 13.76 tons;

1912, average yield per acre 15.40 tons;

1913, average yield per acre 13.13 tons.

Wheatland, Wyo. yield for 1911 was about 65% of Eaton yield per acre.

3514 Wheatland yield for 1912 was about 64% of Eaton yield per acre;

Wheatland yield for 1913 was about 56% of Eaton yield per acre.

Sugar content of beets raised in Wheatland territory for 1911 was somewhat higher and also 1912, than Eaton factory, but for 1913 was a trifle lower than that of Eaton territory. Wheatland district average sugar content for respective years is as follows: 1911, 17.93% sugar; 1912, 17.79% sugar; and 1913, 15.6% sugar. In Eaton factory sugar content for respective years was as follows: 1911, 15.84% sugar; 1912, 16.84% sugar and 1913, 15.64% sugar.

Difference in per cent of sugar during years 1911 and 1912 in favor of beets in Wheatland area, so far as revenue to growers is concerned, is not sufficient to offset difference in tonnage in favor of Eaton district for same years. It would not cover a considerable portion of difference so far as growers are concerned.

Aggregate tonnage of beets grown and furnished Eaton, Greeley and Windsor factories for years 1911, 1912 and 1913 are as follows:

Eaton factory, 1911, 61,930 tons; 1912, 160,965 tons and 1913, 217,899 tons. I want to qualify that for years 1912 and 1913 with supplemental statement that we received in Eaton territory in 1912 and '13 small tonnage from Campbell, Nebraska, territory. It

3515 was insignificant, probably about 3000 tons. Practically all beets for Eaton factory are raised within radius of 15 miles of factory, with exception of Campbell, Nebraska, territory where we took a few beets. The tonnage of latter points is very insignificant.

Greeley factory is as follows: 1911, 84,487 tons; 1912, 121,727 tons and 1913, 137,484 tons.

Windsor factory as follows: 1911, 58,446 tons; 1912, 138,931 tons and 1913, 172,876 tons.

Territory of Eaton and Windsor factories most nearly corresponds with lands that go to make up Greeley-Poudre Irrigation District.

1913 tonnage for Fort Collins Factory was between 150,000 and 160,000 tons. Yield was trifle under 12 tons per acre. This tonnage included 3941 tons from Wheatland area.

A. V. OFFICER.

3516 Cross-examination by Mr. John D. Clark:

I did not visit the Wheatland District in 1913, but from the conditions in Colorado and the reports from that district I should believe that the falling off in the production and in the quality of beets at Wheatland was due to climatic conditions. I do not know whether there was any complaint of shortage of water. In the main we have always been able to supply sufficient help for beet culture at Wheatland. In 1910 we paid $4.50 a ton for beets at Wheatland and in 1911 $5 a ton, and in 1912 and 1913 have paid the
3517 same scale as in Colorado less 40 cents a ton for freight, in 1912, however, guaranteeing a minimum of $5 a ton and paying the same minimum in 1913. We had canvassed the Wheatland district for contracts for the year 1914, and expect to operate there if sufficient acreage is subscribed. As in Colorado the reduction in the price we offer has probably influenced the acreage subscribed, and the Wheatland yield of 7.36 tons per acre in 1913 may have a like effect. I believe we will have 600 acres subscribed in the Wheatland district for 1914 with the price reduced to $4.50 a ton irrespective of sugar content. In 1913 the Wheatland beets averaged about .35 of one per cent higher in sugar content than the general average of beets at Fort Collins. For the year 1914 we have contracted for sufficient beets to give us a 100-day campaign
3518 at Greeley, a 90-day campaign at Windsor, and a 140-day campaign at Eaton, from which territory we will divert beets to Fort Collins and Loveland, and we expect an additional acreage of about 10% to be subscribed. The length of the campaign is based upon the estimated yield in the Eaton territory of 14 tons per acre and in the Windsor territory of 13 tons per acre, and in the Greeley and Fort Collins areas of 12 tons per acre.

3519 Redirect examination by Mr. Delph E. Carpenter:

Term "campaign" represents period that factory is actually engaged in slicing beets from which sugar is made. Factories are able to slice and manufacture into sugar during each 24 hour period the following tonnage: Greeley factory, campaign 1913, daily average slicing capacity was 1003 tons which was maintained through campaign; Fort Collins factory it was 2050.6 tons; Windsor factory about 1100 tons and at Eaton factory about 1088 tons.

Campaign over given period of days would be campaign consuming tonnage of beets obtained by multiplying capacity of factory per day by number of days of campaign. Tonnage I have given you as harvested tonnage in respective territories, is not necessarily tonnage that would be sliced by individual plants, for reason that we divert beets from Windsor and Eaton factories and sometimes from Greeley factory to Fort Collins and Loveland factories. For campaign 1913 ran number of days at Greeley factory with average of 1003 tons per day. To ascertain total tonnage manufactured at factory, multiply the length of campaign by daily tonnage.

3520 Cost of producing an acre of sugar beets under irrigation throughout territory with which I am familiar varies according to conditions of grower. Cost of producing an acre of sugar beets outside of use of land and water, assuming that to be present for production of all crops, I would estimate at from $37.50 per acre up to probably $45. per acre. It would be necessary for farmer to receive that amount of return per acre before he would be able to derive any profit from use of his land and water from growing beets, based on prevailing price for hand labor and team work. Price paid for hand labor, team work, tonnage delivered and length of haul all enter into difference in cost per acre. It costs more to deliver heavy tonnage with long haul than the same tonnage with a short haul. Aside from haul, another factor which must be figured is question of fertilization of land.

Assuming land is not fertilized, I should think it costs about as much to raise an acre of beets producing 15 to 18 tons as it does an acre producing 9 tons, outside of hauling, unless you were planting alfalfa lands where it was necessary to do two plowings. If
3522 conditions are same, if there is no fertilization, same cost of preparing ground obtains it would be safe to say that it would cost as much to produce an acre of 9 tons of beets as it would an acre of 16 tons beets, outside of transportation of crop. The 1914 labor contract, however, is based somewhat on crop yield. Difference is small. 1914 contract provides for payment of $18. per acre with an additional payment of 25 cents per ton on each ton above average yield of 12 tons per acre. Below 12 tons per acre full price of $18 per acre for hand labor will prevail.

Small returns per acre in Wheatland area has had a discouraging effect to contracting of beets in that section.

Growing season Wheatland area is about 2 weeks later than growing season Poudre Valley area. I judge from observations there in spring of 1910 and from reports from our agriculturalists. That is in spring of year. Season closes a little earlier in fall but they have ample time within which to complete their harvest.
3525 I think Wheatland area is adapted to production of sugar beets, perhaps not quite so profitably as to grower in Colorado. Soil is not uniform and as extensive in that area as it is in the Poudre Valley. They have good deal of very fine soil in Wheatland territory and also some soil that is not so productive. I think some of soil there, from observations and investigations made, was rather shallow in some localities. I am of impression that the western portion of area was the less productive.

With return of the potato crop in the Cache la Poudre Valley, acreage of sugar beets planted in 1914 will be less. In certain localities there will be more potatoes. That applies principally to Eaton territory and small portion of Windsor territory. There
3523 will be more potatoes planted in 1914 than in 1913. As I understand 1913 acreage of potatoes was about 25% of 1910 acreage. There was corresponding large increase of acreage of sugar beets in 1913.

It is problem for farmer in Wheatland district to realize cost of

production from his sugar beet crop, with average production of about 9 tons per acre with price of 1914. His margin would be comparatively small based on team work at $4.50 per day for 2 horse team. If farmers were only to realize the 1913 average of 7.36 tons per acre, margin of profit would be correspondingly reduced. If he hired all of the work done, I question seriously whether he wou'd realize cost of production or any more than break even.

In final analysis difference between Eaton area and Wheatland area, in production of sugar beets, lies in aggregate net return received by farmer so far as community interested is concerned.

Average tonnages of any of factories refers to measured acreage harvested and delivered to factories. We have yields in all territories varying probably from 9 to 25 tons per acre. I refer to Colo-
rado territories. In Wheatland territory I presume there
3524 would be a similar proportioned variance. Undoubtedly there are people there who have operated at a loss and some of them at a profit.

3525 Redirect examination by Mr. Delph E. Carpenter:

Difference of yields following differences of precipitation particularly applies with regard to spring precipitation. On account of fact that at that critical growing period, plant requires rainfall. Irrigation at that period does not supplant rainfall. The sugar beet plant at that stage of growth, is good deal more fragile than it is later. Other factors enter, such as condition of ground, and diseases of some sort are apt to develop and reduce both sugar content and yield.

After first year farmers have usually obtained sufficient experience to qualify them to grow sugar beets with proper degree of success, with assistance they are given from our experienced agriculturalists. We hire experts who make it their special business to assist growers in proper culture of their beets. Same condition has prevailed in Wheatland territory in that regard. We have had field men there every year since we have occupied that territory.

Fall rains tend to reduce sugar content of beet crop. If
3526 we have heavy storms after September 25 and heavy precipitation after that time, beet would drop in sugar content and if it continued wet for a week or two, it is questionable whether beets would ever get back to normal.

Sugar beet harvest commences September 25.

JOHN E. FIELD, continued.

3527 Direct examination by Mr. Delph E. Carpenter:

Flow of Laramie River and tributaries for year 1913, has been to some degree considered. This year, 1913, is of interest because it is a year of extreme low flow. Probably no year of which we have record had so small a run-off, unless it was 1902. Percentage of 1902 run-off on Poudre was about 51% of normal. Of all years of which we have records at Woods Landing, 1913 is lowest with 51%, next lowest being 1896 with 55%.

Therefore, if it is shown that this year, 1913, furnishes sufficient supply of water, there could be no question relative to supply, especially with reservoir systems now constructed and more particularly with Wheatland Reservoir No. 2 occupying as it does a very strategical position near northern end of Laramie Plains, where all of water, whether waste, seepage, flood or low flow is intercepted.

Other reservoirs in valley are filled by inlet ditches from stream. These inlet ditches necessarily are of limited capacity and it is impracticable to build them large enough to carry the stream floods. These extreme conditions might occur but once in five years and so large an investment would not be justified by amount of water caught at these rare intervals, but with reservoir across channel of stream as in case of Wheatland Reservoir, without extra expense these additional waters can be conserved and used.

3528 Same is true in cases of breakage of inlet canals for the upper reservoirs. Any canal which breaks or any reservoir which discharges water, any waste or escape water from different sources, will be intercepted by Wheatland Reservoir. It is a reservoir of large capacity and will be able to conserve all of the flood waters except possibly such abnormal conditions as obtained in year 1909. Use of reservoir is to equalize flow in river and to permit owners to conserve surplus waters of one year for use in subsequent years of lower flow. Reservoir lies not far distant from point of application and outflow can be controlled with considerable efficiency, and with Reservoir No. 1 on the Wheatland area, any surplus water which might be turned into river, or which on account of torrential storms, waters of which come into reservoir and tunnel or which fall on water sheds of Blue Grass and Sybille Creeks, can be carried through inlet canals and, if not needed for immediate use, can be stored in Wheatland Reservoir No. 1. So that practically all water available is controlled, even that which comes in below Wheatland Reservoir.

Referring to James Lake Reservoir and to storage of water during 1913 and the use thereof, Mr. Sevison, witness for plaintiff, among other statements thought that there were 3,000 acre feet stored for March, 1913. Mr. Meeker says on plaintiff's Exhibit K and L that there were 18,400 acre feet in the reservoir November 25, 1912; 20,400 acre feet April 25, 1913 and 19,800 acre feet October 30, 1913, showing a gain for this reservoir of 2,000 acre feet over and above all uses and losses. Records also show that inflow into Lake James in 1913 was 12,310 acre feet. These figures indicate a use and loss during season of 10,910 acre feet.

3529 I have discussed incidentally the 1913 conditions for Wheatland Reservoir No. 2 in my statement for 1912, but it is perhaps well to repeat a portion at this time and make other statements.

Figures given in discussion of year 1912 showed there were 47,000 acre feet in storage in Wheatland Reservoir No. 2 at end of year 1912. This amount was available for use in 1913. Inflow as shown by records at Lookout Station was 78,678 acre feet, making total supply for 1913 of 125,678 acre feet. Outflow as shown by

records at McGill Station, was 96,318 acre feet and there should therefore be left in reservoir 29,360 acre feet and there was probably this amount left less losses during year from evaporation. Making allowance for evaporation, I estimate that amount left in reservoir at end of 1913 was 14,360 acre feet. This agrees almost exactly with figures given by Mr. Meeker in his Exhibit K, wherein he states that on November 19 there was 9000 acre feet. Inflow and outflow between November 19 and end of the year, increased this amount until January 1, 1914. Amount is shown to be 14,525 acre feet. Mr. Meeker says further on Plaintiff's Exhibit K, that on April 29, 1913, there was 76,000 acre feet in reservoir. On May 5, I visited this reservoir and observed height of water surface. It was within
18 inches of extreme high water mark made by big flood
3530 of year 1909, in which year dam was threatened with destruction and only utmost efforts on part of owners succeeded in saving dam to prevent water from passing over it.

Capacity of reservoir, as I have previously explained, is 123,000 acre feet, that being average between capacities as stated by Mr. Elliott and capacity stated by Mr. Johnston. Under assumption that high water area of reservoir was 7000 acres, amount of water in reservoir on May 5, can be figured. The 18 inches which reservoir lacked of being full would mean about 10,000 acre feet less than full. This would indicate that amount stored May 5, was 113,000 acre feet.

Between April 29, date of Mr. Meeker's report, and May 5, date of my visit, inflow by records of Lookout Station was 6000 acre feet. Adding this to Mr. Meeker's estimate, amount in reservoir on May 5 should have been 82,000 acre feet as against 113,000 acre feet, showing a discrepancy in amounts stated to be in reservoir of 29,000 acre feet. Inflow after April 29, shown to be 51,000 acre feet and basing amount of water on Mr. Meeker's figures, there would have been in or passed through reservoir during season 127,000 acre feet. McGill Station shows an outflow of 96,000 acre feet, which would indicate that there was left in reservoir 31,000 acre feet less evaporation.

Allowing 15,000 acre feet for evaporation, there would be left 18,000 acre feet in reservoir at end of year, as against amount recorded by Mr. Meeker of 9000 acre feet on November 18. However, after that date, 6500 acre feet was amount of inflow between November and December 31, which leaves difference of but 500 acre feet, so that relative amounts between two dates seems to agree although
actual total amount disagrees on account of different assump-
3531 tions as to capacity of reservoir.

In year 1913 notwithstanding fact that company ran an abnormal amount of water and there was 19,492 acre feet escaped down Sybille Creek, there was left in Wheatland Reservoir No. 2, for use of Wheatland tract, 16,000 acre feet of water available for use in 1914. So that, even very dry year of 1913, did not exhaust available supply in this reservoir.

Wheatland Reservoir No. 1, is reported to have had in November 2nd, 1913, 2,100 acre feet remaining. So that in this very dry year, even its reservoir supply was not exhausted. Wheatland Reservoir

No. 1 is located in midst of Wheatland area and near town of Wheatland. It is so situate as to be able to impound waters flowing from Sybille Creek as well as from Laramie River.

Water stored and used in Lake Hattie in 1913. It was reported that in April, 1913, there was 19,400 acre feet in the reservoir and in November 26,000 acre feet, a gain above uses and losses in this year 1913 of 6,600 acre feet. It has been previously stated by me that 16,870 acre feet were used in 1913 and 5,000 acre feet evaporated, so that in 1913 company controlling Lake Hattie reservoir was able to increase its storage, 7,300 acre feet, this 7,300 acre feet being for entire year, while 6,600 acre feet was from April to November, inclusive. On November 20, 1912, it has been stated by plaintiff that there were 18,700 acre feet in storage. On Plaintiff's Exhibit I, we find that 28,470 acre feet were run into Lake Hattie in 1913, making total of 47,170 acre feet available from reservoir in addition to this 13,504 acre feet, which were carried through Pioneer Canal proper, making 60,674 acre feet available for this system 1913.

3532 In practice, even under good ditches, a short supply once in 5 or 10 years is to be expected, with a short supply one year in three the project is still feasible and percentage of crop production will equal percentage of crop in humid regions. It is not practical to limit irrigation development to those projects which have absolutely sure supply in years of extreme drouth. Furthermore in this project more water could have been stored in 1912 had works been in condition to receive such water and had efforts been made to secure a larger supply. No water whatever being run from Little Laramie River in 1913, as has been previously shown, practically 62,000 acre feet of dead space was filled in 1912.

This 62,000 acre feet of dead space, filled in 1912, should be considered active when considering the available water in Laramie River. If this water had not been placed in dead space but on contrary in active space, reservoir would have been entirely filled and there would have been a surplus of some 12,000 acre feet, which would have remained either in river or passed over spillway.

Adding this 62,000 acre feet to what was actually available, 60,674 acre feet, we have a total available of 122,673 acre feet or enough to irrigate probably 100,000 acres.

Records of flow at mouth of Sybille Creek, as I have stated, in 1913 was 19,482 acre feet. The greater part of this water should have been conserved and would have relieved drought on river

3533 by that amount. At Wheeler Bridge below Wheatland Reservoir, on east side of Laramie Mountain, discharge in 1913, April to September inclusive, and for 25 days in October and 22 days in November, was 6,913 acre feet. For entire year discharge was probably in excess of 10,000 acre feet.

There are no records for Chugwater discharge for year 1913 nor for North Laramie River. They all probably did not discharge a great amount of water and it would be my judgment that discharge of Chugwater would be similar to its discharge in 1911, about 2,000 acre feet.

On account of increased storage effected during 1913, it is appar-

ent that there was no shortage in this year, although there was carried over from 1912, 94,600 acre feet. This is exclusive of the 62,000 acre feet held in dead space in Lake Hattie Reservoir.

Even in years of extreme shortage, and assuming that Colorado was diverting all the water she could by physical conditions divert, there is still a means of supplying any possible deficiency of water supply in the Laramie Valley.

It is well to call attention at this point to fact that State of Wyoming has it is disposal a considerable water supply that will make up any possible deficiency in years of very low flow on Laramie drainage.

This possible deficiency can be made up by means of ditches diverting water from Douglas Creek, a tributary of North Platte drainage. The Laramie Water Company is already providing itself with such a supply and has commenced construction of ditch from Douglas Creek, which will bring waters from North Platte across divide into Laramie drainage, through construction of Bell Supply Ditch No. 2, commonly known as Douglas Creek diversion. This water will first be discharged into Little Laramie River and then diverted from that stream and will be available for Lake Hattie System, thereby overcoming any possible shortage that might
3534 exist in years of extreme low flow. Construction of this Douglas Creek diversion may have been contemplated by projectors of Lake Hattie enterprise, owing to fact that they already well knew of notorious and open construction for many years previous of Greeley-Poudre system on upper reaches of Laramie drainage in Colorado. I think more likely, it was due to a lack of appreciation of large amount of water in Laramie River which was available for their project. These caused them to seek this other supply. The very dry year of 1913 might influence supply of water for 1914. 1914 promises to be a year above normal, so that although amount of stored water at end of 1913 was not as great as it was at end of 1912, there is no possibility of a shortage in 1914.

Percentages which I have already given and which represent the Colorado diversions made by the Sky Line Canal, the Divide or Sand Creek Canal and the Greeley-Poudre Systems during normal years, will presist in years of low flow. In years of high discharge the percentage diverted by Colorado would probably be less. Diversion by Colorado in 1913 by Sky Line Canal was 15,000 acre feet, about
75% of what it had been discharging annually, and about
3535 2/3 of what was carried across divide in 1912. In 1913, there passed Lanning Bridge (which is situated about 1 mile below mouth of tunnel of Greeley-Poudre Irrigation District and is across Big Laramie River and is about 1 mile below west fork of river), May 1 to July 1, 5600 acre feet. In 1913, April 21 to October 19, there passed Glendevey Station 34,368 acre feet, all of the 5600 acre feet could have been diverted and probably would have been diverted by the Greeley-Poudre System, diverted through the tunnel, and a percentage of balance which passed Glendevey Station would have been diverted. It is not probable that more than 30,000 acre feet would have been diverted, than was actually diverted that year. I refer to

the actual diversions by the Sky Line Canal. If the tunnel had been operated not more than 30,000 acre feet additional would have been diverted.

This 30,000 acre feet is less than the amount stored during 1913, and only about ½ of amount carried over from year 1913 to year 1914. Amount carried over from year 1913 to 1914 was as follows: Wheatland Reservoir No. 2, 15,000 acre feet; Wheatland Reservoir No. 1, 3000 acre feet; Lake James, 19,800 acre feet; Lake Hattie, 26,000 acre feet; totaling 63,800 acre feet, or as I have said, there was carried over more than twice the full amount which would probably have been diverted by the Greeley-Poudre System in year 1913.

In speaking of the 30,000 acre feet probable diversion by the Greeley-Poudre system on the Laramie River in a year like 1913, I refer to that system without the addition of the Lower Mc-
3537 Intyre Extension. I stated that in normal year the diversion of that canal would be about 15,000 acre feet. In this year, 1913, amount diverted by possible extension to Lower McIntyre I believe would have been approximately 9,000 acre feet. During months of June to September inclusive, discharge of Upper McIntyre gauging station was 8,923 acre feet. That station is located a short distance below point of diversion of possible extension of Lower West Side Collection Ditch of The Greeley-Poudre System. A part of this quantity would have been diverted by the Upper Rawah Ditch from the Upper McIntyre, but water would probably have been running in month of May in anticipation of a shortage, so that I believe it would have been possible to have gotten 9,000 acre feet more by such an extension in this dry year.

I included in this 9,000 acre feet additional, what little water would enter canal from intervening streams between McIntyre and Rawah Creeks, and which would be intercepted by Lower Extension.

Percentage of possible diversion by intermountain ditches and tunnel in Colorado, will remain about same in dry years as it will be in wet years, in low years as well as in high years, especially with reference to diversion by the Greeley-Poudre System. That is not true, I think, with reference to Sky Line Canal. In year of low flow they would make an extra effort to get more water, as
3537 they have in past; but that extra effort on their part would result in decreasing amount which Greeley-Poudre system could divert in low year, so that new diversion which is proposed by Greeley-Poudre system would be about same expressed in percentages for high years, normal years and low years.

When I gave 90,000 acre feet as the maximum possible diversion for all time from Laramie River in normal years by various intermountain diversions in Colorado, I did not intend that that amount in acre feet should be deducted from the Colorado Laramie River flow in all years. To better illustrate perhaps impossibility of diverting so large a quantity of water, I call attention to flow at Glendevey in 1913, between April 21 and October 19, which would be a period when ditches could be operated. Flow at Glendevey was 34,388 acre feet. Greeley-Poudre system could not have obtained

even all that supply. There would have to come out of that supply the diversion for the Divide Ditch (Wilson Supply Ditch) and amount which comes into river below Collection Ditches and necessary losses from seepage and from limited capacity of collection ditches. Even this year, it is probable that Collection Ditches could not carry all of water which might be discharged from drainage area. Average discharge during day does not represent peak of flood. There is a very considerable fluctuation during the day itself, and, through accidents and otherwise, some water would get away and not reach mouth of tunnel. I refer to some of the water which, theoretically, might be diverted.

I stated that it would be necessary to deduct from the 1913 Glendevey flow, the Divide Canal diversion, for reason that canal
3538 did not carry any water across divide into Poudre that year. It is fair to assume that the Divide Ditch will carry water in other years and therefore deductions should be made as I have stated.

I have prepared diagrams or graphs for year 1913, similar to diagrams prepared for water flow in Laramie River and tributaries for year 1912.

(Defendants' Exhibit 137, mass diagram, offered in evidence.)

Exhibit 137 is mass diagram, showing condition at several stations on Big Laramie River between Sky Line Canal and Woods Landing, Wyoming, for year 1913.

Exhibit 137 should be considered in connection with Exhibit 132, for purpose of comparison between years 1912 and 1913. The two exhibits are similar and were constructed on same basis.

In Exhibit 137 diagonal hatched area at the bottom of graph, as shown by legend and marked "Sky Line and Divide Diversions" represents diversion by Sky Line Canal for that year. Area cross-hatched by diagonal lines immediately above that one, shows run-off tributary to tunnel and through Collection Ditch system of Greeley-Poudre development. Horizontal hatched lines represent amount of water coming into river between tunnel and Boswell Ranch Station, and area hatched by vertical lines represents graphically amount of water which flows into Big Laramie River between Boswell Ranch Station and Woods Landing Station. Columns as whole represent total supply of river at Woods Landing Station.

(Defendants' Exhibit 138, a hydrograph, offered in evidence.)

3539 Exhibit 138 is similar to other hydrographs which have been introduced, and in explanation would say that lower and unhatched areas in which words "Lake Hattie and Two Rivers" appear, is area representing amount of water passing those two stations. In case of January, February and March, amount passing two stations was practically identical and is therefore marked and credited to both stations. In April, it was credited to Lake Hattie, that being larger area. In month of May, words "Two Rivers" appears on unhatched area for that month, represents discharge at Two Rivers for May. The same is true for month of June. Discharge

of Two Rivers is shown also for months of July, August, October and November. In December amount is credited to both Two Rivers and Lake Hattie Stations. I don't mean to say that this area represents amount of water furnished Lake Hattie, but the amount which passed gauging station at head of Lake Hattie Inlet No. 2, the canal from the Little Laramie River. Area marked solid blue is loss of water unaccounted for between head of Bellamy Canal and station at Lake Hattie Dam No. 2. The next area which is hatched in a diagonal direction and is shown by legend, represents loss and use between Lake Hattie Inlet Station and Two Rivers. This area was obtained by taking total flow at gauging station at Filmore and deducting from it amount of water at Two Rivers Station and amount of water which was supplied to Bellamy Canal. Area is ob-
3540 tained by process of subtraction and does not represent direct measurements. There is a small area marked first with horizontal lines and then with diagonal lines stated on legend to represent gain between Filmore and Lake Hattie Inlet. In this connection I will state that at times there appears to have been a gain between Filmore Station and Lake Hattie Inlet and other times a loss. There will also be observed an area where diagonal hatching is in both directions, making a diamond shaped appearance in the area. This, according to legend, represents increase between Bellamy Canal headogate and Lake Hattie Dam No. 2. The area with horizontal cross-hatching represents gain between Lake Hattie Dam No. 2 and Two Rivers, while area at top of diagram for April, May, June, July and August represents diversion by Bellamy Canal itself and part of which water was discharged into James Lake. The outer boundaries of the diagram for months of May and June, do not represent graphically total supply of river unless one should take into account fact that there is an increase between Bellamy Canal and Lake Hattie Canal as shown by double hatching. This area should be used twice to give total supply.

(Defendants' Exhibit 139, a hydrograph, offered in evidence.)

Exhibit 139 or diagram is a use diagram. That is, it is supposed to show what becomes of water and waste of Laramie River between Two Rivers and Lookout. This diagram shows particularly use and losses and gain between those two stations, this being for year 1913.
Legend shows that use and loss between two stations for this
3541 year was 2,650 acre feet and gain between two stations for this year was 2,000 acre feet. This is net gain and represents gain over and above use which might have been made of waters of river between those two points at the time shown. This 2,000 acre feet of gain is in months of April, May and August. It is quite small in August, due in all probability to fact that more water was used in that month than during month of April or May. Absence of gain in months of June and July is accounted for and fact that a loss appears in those two months is probably due to use of water between stations.

(Defendants' Exhibit 140, a hydrograph, offered in evidence.)

Defendants' Exhibit 140 is diagram similar to Exhibit 135 and was constructed in same manner. Principal difference being I show on this Exhibit 140 difference which would appear if 123,000 acre feet was assumed as capacity of Wheatland No. 2 reservoir instead of 83,000 acre feet. In designating the difference, the portion of diagram based on capacity 123,000 acre feet is represented by upper diagram, the lines of which are indicated by B′ and C′ and lines marked B and C represent conditions under asumption that capacity was 83,000 acre feet. On original drawing of this diagram, lines marked B′ and C′ were drawn in red. In making blueprint red shows same as though it were black ink, necessitating use of letters B and C and B′ and C′ to distinguish them. Upper line marked B and B′ represents inflow into Wheatland Reservoir No. 2,
3542 according to records at Lookout Station. Lines C and C′ represent outflow as shown by records at McGill Station. Dotted line represents amount of water reported in reservoir. Lower of two dotted lines showing position according to report of Mr. R. I. Meeker. Upper dotted line was placed by making correction for difference in assumed capacities. A portion of diagram is cross-hatched between B and C′, this cross-hatching was placed on diagram to call attention to overlapping of two diagrams and has no other significance.

(Defendants' Exhibit 141, a hydrograph, offered in evidence.)

Defendants' Exhibit 141 is a mass diagram for 1913 and, similar to Exhibit 136 for the year 1912. Upper line represents accumulating supply. Lower line represents use and disposition of water. Total supply being about 235,000 acre feet for this year. It will be noted that any reference to Chugwater Supply has been omitted for reason that we had no records on that stream for 1913. In fact Chugwater supply does not affect areas which we have under consideration except as it supplies diversions for water on land below the mouth of Chugwater Creek. There is shown on upper line quantities entering river between various stations. In this year it is shown that 15,222 acre feet were diverted by Sky Line Canal; that 42,095 acre feet were diverted by Pioneer Canal for Lake Hattie and Pioneer Canal itself. That loss and use between Pioneer Canal Dam and Two Rivers Station was 22,682 acre feet, in addition to whatever inflow might have occurred between those two points. Quantity furnished by Little Laramie River at Two Rivers was 25,300 acre feet and loss or use between Two Rivers and Lookout Station was very small amounting to
3543 about 623 acre feet. This very small amount resulting in an almost horizontal line between the two stations. I have shown on this exhibit something that was not shown on Exhibit 136, namely, amount of stored water which was held over in Wheatland Reservoir No. 1 and Wheatland Reservoir No. 2 in amount 57,500 acre feet. This quantity is shown because it was available for year 1913. There was discharged out of reservoir 95,992 acre feet, there appears on lower line between McGill and Wheatland Stations figures 7,500 acre feet. This represents amount of water

which was used out of Wheatland Reservoir No. 1. There also appears a bracket with an arrow pointing to words "Storage and waste in Reservoirs Numbers One and Two end of 1913." Amount of water passing Wheeler Bridge is also shown opposite that station in amount of 10,000 acre feet and inflow through Sybille Creek is also shown in amount of 20,000 acre feet. On right side of exhibit are two columns. These represent in another way the same things that are shown on the graphs, and on lines in main part of diagram, and these columns show clearly amount of water which was used from Wheatland No. 2 Reservoir and also amount which was used from Wheatland No. 1 Reservoir. It shows amount of stored water which was used not only in 1912, but also that which was stored in 1913.

Sybille Creek supply is charged to loss as that amount of water passed down river unused. Amount which passed Wheeler Bridge is also marked loss. In amount these two are 30,000 acre feet or about amount which would have been diverted by Greeley-Poudre Tunnel had it been in operation.

(Defendants' Exhibit 142, a hydrograph, offered in evidence.'

3544 Defendants' Exhibit 142 shows graphically the supply and use of waters of Laramie River in so far as it relates to total supply of river and to diversions being made from Laramie River to both Cache la Poudre by Sky Line and Divide or Sand Creek diversions and by the Greeley-Poudre District diversion.

It represents a normal year, supply being for amount supplied by Colorado alone and it does not include supply which originates in Wyoming. The column marked No. 1 represents average diversion of Sky Line and Divide or Sand Creek Ditches. Column 2 represents diversion by Greeley-Poudre District system, which it will make when its system is in full operation along present plans. Column 3 represents diversions which may occur if Lower McIntyre diversion is completed while Column 4 represents sum of diversions by Sky Line and Divide or Sand Creek Ditches and amount which may be ultimately diverted when the lower McIntyre diversion is completed.

This gives to the eye a representation of relative appropriations and diversions and amount supplied by Colorado. Amount supplied by Colorado is represented by solid blue area in Column 5. Cross-hatched area at top of Column 5 represents 17,000 acre feet which Sand Creek furnishes. Column 4 shows graphically diversion possibilities of all works either constructed or now under construction or planned within Colorado areas and represents not only those but all future or possible diversions.

3545 Scale at right of diagram is based on supply exclusive of Sand Creek supply. Total supply represented being 237,500 acre feet.

Scale at extreme left represents acre feet but scale at right represents percentages as indicated. To illustrate, when I speak of scale to extreme left I mean figures appearing on extreme left of sheet.

Percentage scale is indicated by broken line and by words "Percentage Scale Diversions of Total Mean Run-off Colorado-Wyoming line."

Same general percentage will prevail even in years of less than normal run-off. This may be taken as graphic illustration of diversions in various particulars illustrated.

3546 It is necessary to consider exhibits introduced by the plaintiff, particularly those having to do with tabulated water discharge records, etc., in order to properly show relation of those exhibits to actual water flow of Laramie River as exhibited by tables I have already introduced and also to consider possibly the exhibits which were produced by plaintiff and more particularly by R. I. Meeker, that were identified on cross-examination which have not yet been introduced in evidence. I think it is necessary to review the statements made on some of these exhibits and I have taken up part of them with idea of ascertaining wherein their possible values lie in connection with the case.

General criticism of those having to do with alleged normal flow of Laramie River and tributaries is that records used are confined to 1912 and 1913 almost entirely and conclusions are drawn from records of those two years only. Some of records were incomplete at time evidence was introduced, records were subsequently obtained, and therefore corrections should be made.

3547 Plaintiff's Exhibit I, showing Laramie River run-off 1912 and 1913 will first be considered. First criticism that I would make is that run-off at Pioneer Dam is stated on exhibit as 207,000 acre feet is entirely too small. Records at Boswell's for 1912 show 205,678 acre feet. Inflow from Johnson and Beaver Creeks is 27,500 acre feet and there is other miscellaneous drainage bringing the total up to 239,697 acre feet as against 207,000 acre feet, a discrepancy of over 32,000 acre feet. The error appears to lie particularly in discharge for month of June. At Boswell's for June by records made by State of Colorado discharge was 92,912 acre feet. Inflow between Boswell's and Woods Landing that month was 9,914 acre feet, making total of 102,826 acre feet, while Mr. Meeker reports in records which he furnished, a flow at Woods Landing for month of June, but which I believe has not been introduced as an exhibit, 86,003 acre feet, so that there is an error of 16,823 acre feet for month of June alone.

Difference in discharge for year indicated by Boswell records and that indicated by Mr. Meeker's records, is 32,697 acre feet for that year. As table Exhibit I is based almost entirely on total discharge of river for 1912, results are necessarily in error and practically without value. Discharge or amount of water carried by Pioneer Canal is 17,703 acre feet, and that charged to Lake Hattie Reservoir, 69,855 acre feet, I have no means of checking; but amount "Wheatland Reservoir Number Two and intermediate ditches below Two Rivers, 89,550 acre feet" is open to question. Discharge at Two Rivers by records of United States Geological Survey was 94,700 acre feet from April 5 to October 31 inclusive. This discharge would indicate an annual discharge of 120,000 acre feet as against Mr. Meeker's esti-

mate of 89,550 acre feet, or a difference of 32,450 acre feet.
3548 5150 acre feet of this amount is due to slight discrepancies in records and balance is probably due to winter flow not having been taken into account. We may therefore add water which has been accounted for and deduct it from total supply. We have Pioneer Dam 17,703 acre feet, Lake Hattie Reservoir 69,855 acre feet and Two Rivers 120,000 acre feet, a total of 207,550 acre feet accounted for. I have already stated that I have no means of checking the figures given for Pioneer Dam or Lake Hattie respectively. For purpose of last statement I took figures given by Mr. Meeker. Those records were in his exclusive possession. This leaves over 32,000 acre feet unaccounted for, which amount, if we follow process followed by Mr. Meeker in his Exhibit I, would be amount of water used between Pioneer Dam and Two Rivers.

In 1913, which is second table in Exhibit I, total run-off is given, January to November 30, as 106,600 acre feet. This figure is an error also as the record for Pioneer Dam 1913 is given as 109,593 acre feet. This difference, however, was due to incomplete records at time exhibit was presented.

Last column is an error as to amount of water given at Two Rivers at 45,709 acre feet. Geological Survey for this year shows discharge of 54,001 acre feet. Discrepancy is 8,292 acre feet.

We therefore have for 1913 Pioneer Canal 13,503 acre feet; Lake Hattie, 28,470 acre feet and Two Rivers, 54,001 acre feet or a total of 95,975 acre feet. Subtracting this quantity from 109,593 acre feet, we have the use between the Dam and Two Rivers of 13,618 acre feet, not counting inflow between those two points.

The third table on Exhibit I is an error as to practically entire statement in regard to discharges of 1912 and also in regard
3549 to discharge for months of November and December, 1913, as explained above. Aside from any errors, however, shown on this table, third column in table 3 purports to give a mean for 12 months. The mean is obtained by taking actual discharge for year 1913 for January, February and March and for month of December. By taking actual discharge for December, 1912, balance of year has an average between discharges shown for different months of 1912 and 1913.

As I previously stated, year 1912 is very seriously in error but more than that it is misleading to average two years and call it a mean, unless it is definitely understood that it is merely the mean of the figures given and that is thoroughly understood that it is not a mean of the discharge of the river.

The year 1912, as has been stated previously, was one of approximately normal flow, while 1913 was one of only about ½ of normal flow. It is obvious therefore, that any result of adding discharges of these two years would not give mean of discharges of the river.

From Exhibit I, record given by Mr. Meeker which I believe is correct, we are to understand that even in the year 1913, which I state was 51% of normal, 28,470 acre feet was diverted into Pioneer Canal from Big Laramie River. That is in addition also to the amount of water shown to have been diverted for use through the Pioneer Canal

proper. Putting it in another way, diversion of this Lake Hattie and Pioneer statement shows diversion of 28,470 acre feet more water than the 13,504 acre feet diverted and used under Pioneer Canal.

3550 Throughout table Exhibit I, uniform criticism is that flow of water of Laramie River is underestimated by exhibits presented by plaintiff.

Plaintiff's Exhibit J is intended to show same for Little Laramie River as was shown by Exhibit I on Big Laramie River. Records of Geological Survey of 1912 on Little Laramie River April 21 to October 31, give discharge as 109,000 acre feet. For portion of April given discharge was 1,300 acre feet. Discharge therefore, May to October 31 was 107,700 acre feet. This would be about 84% of normal discharge, indicating an annual discharge of 128,000 acre feet. Deducting discharge of Bellamy Canal given on Exhibit J, as 24,793 acre feet, leaves 103,207 acre feet. In order to compare the records with those of Exhibit J, it is necessary to confine ourselves to period June 1 to December 31. The Geological Survey, as I have stated, gives discharge April 21 to October 31, 109,000 acre feet. Deducting May and June flow, we have June to October equals 94,200 acre feet. On Exhibit J we find that discharge June 1 to December 31 was 91,667 acre feet and on tables furnished by Mr. Meeker discharge of November and December aggregated 3,760 acre feet, leaving for period June to October 89,807 acre feet as against 94,200 acre feet recorded by Geological Survey, there being a difference between the two records of 4,393 acre feet for period June to October inclusive, which period is covered by both records.

The amount "The Wheatland Reservoir and intermediate ditches between Two Rivers 37,556" also appears to be an error. Discharge at Two Rivers as shown by Geological Survey records April 1

3551 to October 31, is 42,600 acre feet. Deducting April and May discharge of 7,060 acre feet, and adding for November and December 7,000 acre feet, discharge June 1 to December 1 appears to be 42,540 acre feet, a difference of 5,000 acre feet.

We have therefore for distribution of 1913 on Little Laramie River, Bellamy Canal and James Lake Reservoir, 24,793 acre feet; Lake Hattie Supply Canal, 14,053 acre feet; at Two Rivers, 42,540 acre feet or a total of 81,386 acre feet. Total supply of Little Laramie in 1912 has been given as 128,000 acre feet. Subtracting 81,386 acre feet from this, we have 46,614 acre feet as amount consumed between Filmore Station and Two Rivers exclusive of amount sent to Bellamy Canal and to Lake Hattie Supply Canal. This discrepancy is doubtless in part due to fact that Exhibit J covers the period from June 1 to December 31 only, instead of the entire year. (See correction, p. 3556 as to 46,614 acre feet.)

Tabulation on this Exhibit for 1913 is an error slightly in some respects. Records show supply to have been 59,595 as against 58,361, due to incompleteness of records at time Exhibit J was presented. Flow at Two Rivers is shown to be 24,300 acre feet as against 23,797 and Bellamy is shown to be 12,268 acre feet as against 12,310, leaving for ditches between No. 2 Dam and Two Rivers, 23,027 as against

22,254. These differences, however, are immaterial. The last table on the exhibit is an error on account of the serious discrepancies in records of 1912 and for reason as explained before, that last column of third table can scarcely be considered a mean of the discharge of the months as only two years were used, and in fact only a part of the year 1912.

Exhibit L gives a summary of 1912 and 1913 storage. I would first criticise this exhibit from the fact that amount shown on November 20, 43,500 acre feet, does not represent total amount
3552 stored during that year. As previously stated, I have estimated storage held over from 1912 as 47,000 acre feet. Amount credited to Lake Hattie Reservoir November 20, is 18,700 acre feet. I have no criticism to make of that particular quantity but it should be plain that this is active capacity entirely and that there was, as a matter of fact, diverted into the reservoir 62,000 acre feet besides this amount, which filled dead space and made initial expense at it were.

This water, not accounted for, which went to fill dead space would have been available as active water in that reservoir in any other year than first year of filling. It just happened that year 1912 was first year in which this dead space was filled in Lake Hattie. So that total volume stored in 1912 more correctly speaking would be 156,600 acre feet rather than 91,100 acre feet.

Table referring to storage of 1913 is approximately correct except that it does not show total amount at end of year 1913 but on November 20. If the end of year had been taken amount would have been increased by nearly 5,000 acre feet. Total as I have figured it being 62,254 acre feet. These figures represent of course net storage after all losses from seepage and evaporation have been deducted.

Particular criticism of table Exhibit L lies in fact that allowance was not made for the 62,000 acre feet which was diverted from Laramie River and placed in Lake Hattie to fill the dead space.
3553 Exhibit M is intended to show relative run-off of Laramie River at Glendevey and at Woods gauging stations. Records quoted for 1911 and 1912 are approximately correct, if not entirely so, but year 1912, as previously stated, is seriously in error as to Woods Landing records. This being true, attempt to arrive at percentages results, of course, in incorrect results. Woods Landing records for 1912 to which I refer are those which show a much less flow of water than actually passed that station according to Colorado records. Consequence is that when the low record, Meeker record for 1912, is taken, you are unable to arrive at the correct percentage. Further, in getting a percentage of run-off as between two stations, confining the observations and calculations to three years is apt to lead to erroneous results. That is especially true where two low years and one normal year are taken, which is case in Exhibit M. Years 1911, 1912 and 1913 are taken. 1911 was a low year but not so low as 1913. 1912 was approximately normal. 1913 was very low year. It appears that in order to get percentage of run off it would have been better to take normal discharge at the two stations and compare them. This I have done with result that relation is 77,000

acre feet for Glendevey Station and 215,500 acre feet for Woods Landing Station.

This relation shows that run-off at Glendevey would be
3554 35% of that at Woods. If we had included in these averages the discharge of Sky Line and Divide or Sand Creek Ditches, at both stations, the percentage of run-off at Glendevey would have been 41% of discharge at Woods Landing. This relation is shown by total discharge including Sky Line and Divide Ditches of 97,000 acre feet for Glendevey and 237,500 acre feet the normal discharge as calculated for Woods.

I have already stated that it will be impossible for Colorado to divert all water passing Glendevey Station.

The statement appearing in note at bottom of Plaintiff's Exhibit M and particularly that portion which reads: "Run-off at Woods, Wyoming, for July, August and September represents substantially the entire run-off of the Laramie River basin except the surplus from Little Laramie River basin in occasional years and in considerable amounts produced by summer freshets," is not true. It does not include the amount diverted by Sky Line or Divide Ditches, and the statement "except the surplus from the Little Laramie River basin in occasional years" I think is incorrect, because there is a discharge from Little Laramie River basin in practically all years, not in occasional years. That would be especially true if Lake Hattie people did not divert large quantities of water from that stream. It would also be true if James Lake people did not divert large quantities of water from Little Laramie River.

If these two brand new projects would leave the water of the Little Laramie River alone, there would be considerable run-off every year going down the river toward Wheatland No. 2 Reservoir.
3556 Use of water from Little Laramie River is very wasteful. It is allowed to run over meadows at random and is not taken care of and surplus waters are not re-conducted to channels and in this way a very large amount of water is wasted through evaporation. One reason there is no more water shown to appear at Two Rivers Station on Little Laramie is because of carelessness in failing to return water to channel at earliest possible time. Little Laramie Valley is kept continuously wet and result is that evaporation of water is excessive and waste to a considerable extent is net loss.

To say the least the note just quoted, appearing at bottom of Plaintiff's Exhibit M, is quite misleading.

I desire to give a figure with relation to Exhibit J, which will be comparable and which I did not do this morning. I compared this morning, referring to Exhibit J, amount of water which on Exhibit J was charged to "Ditches between Number Two Dam and Two Rivers, 17,245 acre feet" and which covered period of year June 1 to December 31 only, with figures 46,614 as referring to entire
3556 year. I wish to withdraw the figure of 46,614, so that a comparison can really be made. I stated this morning that total amount of water accounted for as discharged or used by Bellamy Canal, Lake Hattie Supply Canal and as shown at Two Rivers was 81,386 acre feet. Discharge of Little Laramie River for

period June 1 to December 31, is 102,200 acre feet as shown by U. S. Geological Survey records. By deducting flow for April and May, as shown on those records, and adding 8,000 acre feet as discharge for November and December, by subtracting 81,386 from 102,200, leaving 20,814 acre feet as amount used between June 1 and December 31, between Lake Hattie No. 2 Dam and Two Rivers. No. 2 Dam is dam for the Little Laramie Inlet to Lake Hattie. This as against 17,245 acre feet on Exhibit J.

Exhibit K is a résumé of information given on previous Exhibits, and criticism made to those exhibits is of course applicable to this exhibit. In reference to Wheatland Reservoir No. 2, on May 27, amount of water is stated as 36,600 acre feet. This is on assumption that active capacity is about 83,000 acre feet instead of 123,000 acre feet as stated by other authorities. Further, we have no record of amount of water which flowed out of Wheatland Reservoir No. 2 prior to May 27. I have been informed that at one time there were 600 cubic feet per second of water discharged from reservoir in month of April, 1912. I could not ascertain length of time discontinued and could find no records which gave me definite information. Beginning with May 27, which is well along in season, and is date after considerable water had passed down river, leave records incomplete to an extent that makes data not as reliable as it should be.

Statement in regard to Lake Hattie Reservoir on Exhibit K, is open to criticism which I have previously made, that no mention is made of amounts stored in dead space of Lake and which, had it not been first year which Lake had been filled, would have been available for use.

I have prepared a table showing discharge of Laramie River in acre feet at Two Rivers, Wyo., for Big Laramie River for all or portions of years 1909, 1910, 1911, 1912 and 1913 and also showing mean for those years taken as a whole.

(Defendants' Exhibit 143, a tabulation of discharge at Two Rivers, introduced in evidence.)

(COPY OF DEFENDANTS' EXHIBIT 143.)

State of Colorado—Engineering Department.

Discharge of Laramie River (Run-off, in Acre Feet) at Two Rivers, Wyo.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	....	....	....	6,720	21,198	104,854	91,390	8,996	9,900	4,230	5,324	10,292	262,904
1910	12,369	13,585	....	....	18,090	9,930	758	522	468	....	....	....	55,722
1911	....	....	....	....	17,200	28,900	3,410	403	367	1,380	....	....	51,700
1912	....	....	....	6,000	11,100	49,200	16,700	6,640	1,780	4,290	....	....	95,710
1913	2,650	2,355	3,296	11,500	7,133	8,152	2,564	1,629	4,016	3,160	4,300	3,246	54,001
Total ...	15,019	15,940	3,296	24,220	74,721	201,036	114,822	18,190	16,531	13,060	9,624	13,538	....
Mean ...	7,509	7,970	3,296	8,073	14,944	40,207	22,964	3,638	3,306	3,265	4,812	6,769	126,753

Years 1909, 1910, from unpublished records of State Engineer of Wyoming.

Unless otherwise noted, all discharges are in acre feet.

Defendants' Exhibit 143 is a tabulation showing discharge at Two Rivers, on Big Laramie River, for different months and giving, as explained in note at foot of table, records for years 1909 and 1910 from unpublished records in office of State Engineer of Wyoming.

Mean annual run-off, as compiled from those figures, is shown to be 126,753 acre feet.

Referring to Exhibit 136, I will state that that figure does not appear on that exhibit for reason that Exhibit 136 pertains to year 1912 only. It is remarkable, however, that amount shown on chart as amount passing Two Rivers Station on Big Laramie River, is 126,068 acre feet as against mean shown on table of 126,753 acre feet, which seems to confirm the previously made statement that year 1912 was approximately normal.

3558 I have compiled similar table for Little Laramie River near Two Rivers, Wyoming.

(Defendants' Exhibit 144, table of discharge of Little Laramie at Two Rivers, offered in evidence.)

(COPY OF DEFENDANTS' EXHIBIT 144.)

State of Colorado—Engineering Department.

Discharge of Little Laramie River (Run-off, in Acre Feet) at Two Rivers, Wyoming, for 1909, 1910, 1911, 1912, *and* 1913.

Drainage Area, 421 Square Miles.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	....	....	....	4,244	8,042	51,390	24,648	11,366	9,618	7,688	....	....	116,996
1910	....	....	....	....	3,278	2,430	1,446	1,292	1,112	....	....	....	9,558
1911	....	....	....	....	189	10,100	566	0	0	738	....	....	11,600
1912	....	....	....	6,000	1,990	18,500	8,360	2,530	2,610	3,540	....	....	43,530
1913	1,045	1,000	1,476	4,000	4,864	8,390	461	572	149	953	1,300	1,090	25,300
Mean ...	1,045	1,000	1,476	4,748	3,673	18.162	7,096	3.940	3,372	3,230	1,300	1,090	50,132

NOTE.—Years 1909, 1910, from unpublished records of State Engineer of Wyoming.

Exhibit 144 is tabulation showing discharge of Little Laramie River at Two Rivers Station. The mean as determined from these tables being 50,132 acre feet. We have, however, in this table but one record for the months of November, December and January, February and March, these being for year 1913, a year of very low flow. It is remarkable in this case also that the mean as determined from these years is within 7000 acre feet of the amount shown for 1912. A difference in all probability comes in mainly from fact that we have but one record of winter months and that obtained in a low year, 1913.

(Defendants' Exhibit 145, table of discharge of Laramie River at Uva, offered in evidence.)

(COPY OF DEFENDANTS' EXHIBIT 145.)

State of Colorado—Engineering Department.

Discharge of Laramie River at Uva, Wyoming.

Drainage Area, 3,179 Square Miles.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
1895	....	....	....	....	37,200	....	12,052	2,214	892	1,045	....	....	
1896	....	....	....	6,300	14,758	15,471	1,722	3,689	536	....	....	....	
1897	6,149	5,554	9,223	42,367	76,185	62,479	2,460	6,702	714	922	89[illegible]	922	
1898	922	833	1,844	4,522	24,900	38,916	1,660	135	119	154	536	1,107	
1899	6,149	6,109	7,993	58,731	72,432	161,018	94,445	12,482	3,273	4,427	7,141	9,838	
1903	....	....	....	....	13,835	9,699	7,993	1,291	774	676	....	....	
Mean ...	4,407	4,165	6,353	27,980	39,885	57,513	20,055	4,419	1,051	1,445	2,857	3,956	174,086

Table showing average run-off in acre feet for each month.
Unless otherwise noted, all discharges are in acre feet.

Exhibit 145 is table showing discharge of Laramie River at Uva, Wyo. Uva is just below town of Wheatland and station was just above mouth of Chugwater Creek and below mouth of North Laramie. It is also below station previously referred to as Wheeler Bridge.

This exhibit is presented to show amount of water which
3559 passes down Laramie River. Unfortunately records are not of as long a period as is desired, but they give an average mean discharge of 174,086 acre feet per annum. There might be some difference if these years were weighed and compared with discharges at other stations on Laramie and on Poudre, for same period. But it indicates, that a very large amount of water indeed passes down Laramie River.

These records were all made subsequent to inception of a large part of the development of the Wheatland area, and after Pio[illegible]er Canal had been built. These years would be applicable to present time, except for some increased development on Wheatland area and for the very recent construction on the Laramie Plains. Other than these, there has been little change since these records were made.

As compared with Poudre River these years in combination are 119% of normal. I have already stated that taking of 2 or 3 years' discharge of a stream is not a proper basis for determination of normal flow of that stream. Also that in making the Poudre table, Exhibit 124, I took 30 years' records that were on that stream. Referring to discharge of Poudre River, discharge for irrigation season of 1884, gives illustration of remarkable variance that might occur in runoff of any stream during period of only 2 or 3 years. The discharge on Poudre River that year was more than double that of the same time in 1886 and almost equal to combined discharges of 1885 and 1886.

3560 As I have previously stated, the year 1884 was the year of largest flow of which we have record on Poudre River. I have statement of Mr. E. S. Nettleton, State Engineer of Colorado for a number of years, to substantiate this statement. His statement is found in Third Biennial Report of State Engineer of Colorado, on page 57. It reads as follows:

"It will be observed from the above, that the volume discharged during the irrigating season in 1884 was more than double that of the same time in 1886, and almost equal to the combined discharges of the two succeeding years. Whether this decrease has any connection with the destruction of the forests that cover the water shed of the river, it is too soon to determine. The probabilities are that it is accidental, or rather the normal variation in volume which we may expect from season to season. The year 1884 was one of unusually abundant water supply, the largest of which we have any record. Whether we have reached the opposite extreme is to be doubted; the prevailing impression in the district being that there has been seasons of smaller discharge than the last, since irrigation began here."

The volume is dated Denver, Colorado, December 1, 1886, and was probably written in fall of 1886.

The wide fluctuation described in the above statement of Mr. Nettleton, would apply pretty generally to streams of the west. It is a fact that water flow in Cache la Poudre River was lower in years following 1886 than it was during 1886. 1888 was a very low year. The volume discharged during that year April to October, being less than ¼ of that discharged in 1884. The year 1902 was
3561 lower than either 1888 or 1896. There were some high years following that of 1884. Highest year according to Exhibit 124, and covering a period April to October only, was 1909, a year of very large flow having 163% of normal or a little over 2/3 as much as in 1884. Year 1900 was one of very large flow, being also about 2/3 of that of 1884.

Year 1909 was likewise a high year on Big Laramie River.

Inspection of Exhibit 124 will fairly illustrate fluctuation that may occur from year to year in flow of streams in Wyoming-Colorado district.

Relative to duty of water on Laramie Plains Region and in Laramie River drainage in Wyoming, I have shown that normal volume of water available in Laramie River is about 450,000 acre feet per annum; that there will be diverted, when the Greeley-Poudre Irrigation District takes what water it can through the tunnel, 76,000 acre feet. This does not include the extension of the lower West Side Collection Ditch around to McIntyre Creek. If that is included the quantity would be 91,000 acre feet for all Colorado diversions.

3562 Lower McIntyre diversion was estimated at 15,000 acre feet.

After diversion of 76,000 acre feet is made, there would normally remain in the Laramie River for use of Wyoming, 374,000 acre feet of water.

Use of water on the Laramie Plains has not reached high duty that it has in the Poudre Valley, nor has it reached the high duty which we might reasonably expect. Bulletin 67 of the Experiment Station of Wyoming says:

"The time is not distant when present practices must give way to more advanced methods." Again continuing, "the economy in using water of any appreciable value in producing hay crop upon these lands is also doubtful."

In Bulletin 72 of the Experiment Station of Wyoming at page 16 we find the following: "It is probable that a duty of a little under 20 inches of water will give the best results for field peas."

Latter statement is an index of what might be accomplished on almost any crop. This statement relative to 20 inches of water, means that the aggregate depth over the field of the several irrigations during the year would cover the land 20 inches deep or a little over 1½ acre feet per acre.

The methods as stated in the quotation which I made from Bulletin 67 still obtain in Laramie Valley and statement that must give way to more advanced methods is true. They must give way. It cannot remain in the condition it is if water is to be put to use and to attain its greatest good.

3563 It has been my experience that wherever there is no necessity of a strict control of the distribution of water that there is a great abundance, a great surplus of water. Whenever any scarcity begins to be felt a necessity of a careful administration arises. The necessity for putting in proper headgates and controlling works; the construction of waste and return ditches is necessary and these are constructed. Water is no longer allowed to pass down the ditch to some indefinite point below and not used, but waste ditches are made and water is returned to the river at the highest practicable point. This is necessary in order to do justice to the other ditches in the river and to prevent waste.

The prevailing custom of every ditch owner helping himself to water from the stream without supervision is indicative of a large and liberal supply of water. I do not know at what date this custom ceased on Poudre River, but as early as 1876 scarcity began to be felt and this necessity of careful administration and fixing of rights of respective ditches and ditch owners is shown by passage of law of 1879 and 1881, which provided for an adjudication of rights upon the river. There has been very great development and extension of development on Cache la Poudre River since 1876. I have not ascertained what irrigated acreage was in 1876, but as late as 1887 there was, according to report of State Engineer of that year, 108,895 acres of irrigated land or less than ½ of what is irrigated at the present time.

3564 There were claims of shortage of water in Cache la Poudre River as early as 1876. That is, it was thought to be a shortage and there were predictions that the development of irrigation upon the Poudre River had reached practically its maximum, and that no other ditches should be built and it was predicted that those ditches which were inaugurated at that time and constructed, would meet with failure and disaster by reason of lack of water.

The feeling among appropriators on the Cache la Poudre River in 1876 is thus described by Mr. E. S. Nettleton, then State Engineer, in Second Biennial Report of State Engineer of Colorado:

"In 1876, the greater portion of the residents in the lower part of the Cache la Poudre Valley declared that no more new canals should be built, or more water taken from the river. It is a very noticeable fact that new appropriations for canals every year, have been made since 1876 from Cache la Poudre River, and yet no greater alarm exists at the present about scarcity of water than was felt eight years ago. The subsidence of this cry of alarm is also noticeable in other districts."

The above report was for the year ending November 30, 1884 and the letter of transmittal is dated December 1, 1884.

In the Third Biennial Report of the State Engineer of Colorado, at page 57 we find the following:

"Nearly the whole of the discharge of the present season was utilized and needed for cultivation of crops, and, as there are large areas of unoccupied lands under several of the existing canals, the era of beneficial canal building on this stream has probably passed.

Aside from the expansion of the irrigated area, by bringing
3565 the unoccupied lands, situated below existing canals, under cultivation, we must rely on reinforcing of such streams as can be so increased, or by the construction of reservoirs for the further extension of the agriculture of this district."

He was speaking of the Cache la Poudre Valley and of the year 1886.

The above statements of Mr. E. S. Nettleton may be taken as typical of the sentiment prevailing in the Cache la Poudre Valley in the latter seventies and in 1886, which was the time of the last quotation.

The present conditions on the Laramie Plains, the method of use of water, is comparable to the methods of use and distribution prevailing in the Poudre Valley in the late seventies, and is certainly no more advanced than in the very early eighties. I find on page 34 of the Second Biennial Report of the State Engineer of Colorado, a statement which is applicable to the Laramie Plains today and which would seem almost to have been written in reference to the use of water in the Laramie Plains.

"The Water Commission reports that in 1883, he was employed only three days in dividing the water, not having been appointed until late in that year. In 1884 he was employed 12 days, five complaints having been made, all coming from the lower end of the district. The first one, coming about August 1, found some of the ditches in the upper end of the district running full, while those in the lower part of the district had not enough to irrigate their crops. The Commissioner also says, that he had great difficulty in dividing the water before measuring flumes were put in the
3566 ditches, since which time, by using rating tables, he has been able to divide the water to the satisfaction of all concerned. Measuring flumes have been put in nearly all of the ditches in this district, and nearly all of these have been rated, and their discharges tabulated. The division of water in times of scarcity is giving general satisfaction under the law of 1881, although it has hardly been put in full working condition yet."

The similarity between this year of 1883 (and this quotation) with the present condition of the Laramie Valley is apparent, as the testimony heretofore reduced in this case has shown that only a few days were spent by the Water Commissioner in distribution of water on the Laramie Plains in the year 1913, in fact in the last few years. The reference to measuring flumes and their having been put in, shows that the Poudre Valley in 1883 was somewhat more advanced than the Laramie Plains region is today, where very few rating flumes or headgates are found in the ditches.

The irrigated area in the Cache la Poudre Valley has kept on increasing from year to year, regardless of this alleged shortage in the seventies and eighties. It has not increased very greatly in the last 4 or 5 years and what increase there has been appears to have come more from strict economy practiced and careful distribution. The further extension of the irrigated areas in eastern Colorado to my mind is dependant very largely on further economy of use.

I have already stated that economy has so reduced the quantity of water consumed, that there is used at present something less that one acre foot per acre measured in terms of water originally entering the Poudre valley.

3567 There is at present something like 100,000 acres of land irrigated in Wyoming on the Laramie Plains from the Laramie River, including also the Wheatland area, and, as I have stated, the net supply is 374,000 acre feet of water. It has really been more than that up to the present time. That is the supply that will be left after all Colorado diversions have been made. The supply at present time would be about 420,000 acre feet which has been available for Wyoming. Excluding Sand Creek water, in round numbers, supply was something over 400,000 acre feet, in a normal year. Duty of water on Laramie Plains and at Wheatland has been investigated somewhat, but these investigations have referred more particularly to actual use, regardless of what might be accomplished.

In terms of original water entering Laramie Plains and other regions on Laramie River drainage, duty would be about 4 acre feet per acre per annum if all water was used. It is not all used. There is a very considerable waste in the valley. There is considerable water passing out of the valley and there is a great deal of water which is wasted and evaporated without having performed its duty.

3568 Water which is used in Upper Little Laramie and on Big Laramie in Colorado is run on ground during almost entire growing period of hay, and it runs, of course, very quickly back to river and loss from evaporation is not very great. This is method of use in Colorado and in Centennial Valley in Wyoming.

In Laramie Plains District water is taken out of river whenever irrigator finds he wants it. It is not usually given to him by Water Commissioner. He goes and takes it. The water is run out onto the land and there is very little attention paid to the distribution and especially very little attention paid to it during the night. The water is not returned to the river at the nearest point. There may be a requirement under the laws of Wyoming that this be done, as there is such a law in Colorado, but on Laramie Plains it is practically a dead letter. The water, after having been turned into the canal, and if not used, passes on down the Canal and runs into sink holes or lakes and there remains until it is evaporated.

I refer to lakes or depressions without outlets. The waters which are run into them do not return to the river. The Laramie Plains are covered with these depressed areas. The topographic maps prepared by the United States Geological Survey, show very clearly these depressed areas. The map is very small, and the scale is small, so that only a general idea is had from these maps. The entire area is such that one might expect to find depressed acres almost any place. There are some very remarkable depressed areas such

3569 as Big Hollow and Big Basin. Lake Hattie was a depressed area originally and the same is true of Lake James. Cooper Lake is a depressed area where water accumulates, and Hutton and

Creighton Lakes are depressed areas. Small ponds, from a few acres up to 30 or 40 acres are scattered over the plains area and it is in these smaller depressed basins that these waste waters from ditches are discharged or accumulate.

I have caused to be made a computation of the areas contained in these ponds and lakes throughout the irrigated sections of the Big and Little Laramie areas. From what maps I could obtain I had an estimate made of the area of these lakes. There were a great many of them and in the aggregate those which we could locate contained something over 6,000 acres in superficial area. There were a great many that we did not get and we did not take those areas which were wet but did not contain water. We did not take those that did not carry a permanent exposed water surface.

This 6,000 acres of exposed water surface does not include the exposed water surfaces on Wheatland Reservoir No. 2, Lake Hattie, Lake James or other active bodies of water which are being utilized for storage and distribution of water for irrigation. We made an effort to exclude all bodies of water which were used in connection with storage of water for irrigation. It is my judgment that, if we could have gotten all of the small lakes or those lakes which contained water for any considerable time, the area would have aggregated 10,000 acres. It was impossible from our records to get
3570 this quantity exactly and it is also impossible for us to tell what amount of wet land there was from which water evaporates.

Taken as a whole the methods employed in Laramie Plains region are very wasteful. The duty of water in that region is very low. I mean that a given quantity of water serves a comparatively small area of land. It serves a smaller area than experience in other regions demonstrates could be irrigated from the quantity.

The irrigation conditions on the Wheatland area are somewhat different than those on the Laramie Plains area. They have their water supply controlled and there is some effort at having water better administered. Ditches carry very large amounts of water. It is a new co-ntry and naturally demand is quite large and methods have not attained perfection which they will. There is an abundance of water there and economy has not been necessary. Ditches are on rather a steep grade and loss from ditches is probably very great. Duty as shown by amount of water which is claimed to be diverted and used on tract is quite low. It appears that duty at present time on Wheatland area is about 2½ acre feet per acre, which I consider a very low duty.

In the early development of the Cache la Poudre Valley the duty of water was very much lower than that in the beginning. I have examined some ditches where as much as 5 acre feet per acre
3572 were used. Later, as economy became necessary, the duty of water increased.

I would expect that if strict economy ever became necessary in the Wheatland District, the quantity of water used per acre would not exceed 1½ acre feet per acre, that is, measured at headgates of canals. There need be no increased diversion of water from Laramie River

in order to irrigate the original tract contemplated by the Wheatland enterprise. Economy can be practiced on Wheatland area very nicely. As I stated, they have two reservoirs situated in very advantageous positions and there will be no occasion for them to demand any great amount of water. They will only have to demand water when they actually need it and when it can be put to best use.

I did not observe on Wheatland area such waste of water as I did in Laramie Plains region. While there is quite an area of land in the Wheatland tract which has become seeped and wet, the slope of ground is such that surface water does not accumulate in sinks to same extent that it does on Laramie Plains. In older cultivated portions of Wheatland District, I think it is apparent that an excess of water has been used, which is shown by land which has become wet.

3572 If even reasonable economy were practiced on Laramie Plains area the duty of water would rise. The duty would become much higher if reasonable economy were practiced. I think, without any particular effort, that the duty on the Laramie Plains would rise to 2 acre feet per acre per annum. This could be accomplished with scarcely any effort.

Comparing methods on Laramie Plains with those in Cache la Poudre River, water in latter district is under control of the Water Commissioner at all times. The Ditch Companies and Reservoir Companies co-operate with him in trying to make economical use of water. Waste is not tolerated. Wherever there are any depressions in which seepage water accumulates, it is used. Since electric power lines have been put through district, most of water which accumulates in such depressions is pumped out and re-used. Prior to introduction of electric power they used whatever power was available but development along this line has been quite marked since electric power entered district.

In Poudre area water is watched day and night during distribution. The irrigator does not allow it to run to waste. Water is too valuable to permit it to run to waste at night. Such a method does not prevail at all in the Laramie Plains area.

3573 The principal crop irrigated in the Laramie Plains region is native hay, which is grown along river bottoms. There is some grain grown but principal crop is hay. There are some attempts at raising native hay on uplands under Pioneer Canal. These lands, if sufficiently irrigated for two or three years, become covered with growth of grass.

Amount of water necessary to irrigate these hay lands would depend on soil and irrigation season, which is much shorter on Laramie Plains than in Poudre Valley. If water were taken care of and thoroughly and carefully distributed on hay lands on Laramie Plains region, greater economy of water would be accomplished. There is a great waste of water, especially on Little Laramie River. There the valley is broad and flat. The river is divided into several channels. There has been no effort to have a good straight channel or to keep water confined to a single channel, for water is run out of river and is allowed to go into bayous and sinks and there remains.

The ground under Little Laramie River Valley is continuously wet and often in winter it is almost impossible to cross Little Laramie Valley except at certain places. The ground is very wet and evaporation from this wet surface is very considerable. In other words, the Little Laramie River is simply turned loose and permitted to run wild over this bottom from sheep mountain down to the mouth of the stream. Distribution is aided to some small degree by
3574 ditches and by utilizing the numerous channels of the stream.

I saw no evidence on Laramie Plains region of concerted or well defined efforts on part of water users to return waste water to stream from whence it came. I found neither concerted nor individual efforts in this behalf.

I have already stated acreage in aggregate of waste ponds where water is allowed to accumulate and pass off by evaporation. Evaporation on Laramie Plains is quite high, due particularly to high wind velocity, and, while temperature is low, which would retard evaporation somewhat, it is more than made up by high wind velocity and by shallowness of bodies of water. As reported in Experiment Station Bulletin No. 81, some experiments were made both at Laramie and Fort Collins for determination of evaporation from exposed water surface.

Total evaporation for four months from exposed water surfaces at Laramie is given as 27.84 inches. At Fort Collins it is 20.29 inches for same period of four months. This is about what one might expect and the bulletin goes on to say that difference in loss is probably due to wind, which is greater at Laramie, the humidity being about the same, though temperature is lower at Laramie. Losses from evaporation from exposed water surfaces in different parts of arid region are given by numerous writers. A recent publication is by Newell & Murphy, called: "Principles of Irrigation Engineering." In that book they give the amount of losses in different states. In Nebraska 65.57 inches over a period of one year. In Idaho 79.6 inches. It does not give evaporation in Wyoming or on Laramie Plains.

3575 From other data however, which I have consulted, I would state that the evaporation on the Laramie Plains is probably in vicinity of 5 feet per annum or more. Bulletin No. 52 of Wyoming Experiment Station, 1902, gives evaporation from water surface for months from May to September inclusive as 32 inches. The mean for five months being .162 inches per day. This bulletin further says: "It appears that when the water was full in the ditches, within six inches of the top, the evaporation was about one-tenth of that from the water surface," showing that if the water is a short space below the surface of the ground, the evaporation is very much less.

Unnecessary evaporation loss from 6000 acres of exposed water surface on Laramie Plains would be about 30,000 acre feet per annum, if evaporation from water surfaces is 5 feet per annum.

Evaporation from wet areas and from small ponds which we could not measure, and of which we have no record, would probably increase unnecessary loss in valley by an equal amount. In referring

to wet areas I did not refer to the areas wet in usual process of proper irrigation but to other kinds of wet areas where water is wasted on lands in those ponds and depressed areas. Where water remains but short time, loss from such areas on Little Laramie River I have not included. Neither have I included that loss from areas on Big Laramie Valley where hay meadows are irrigated.

Unnecessary loss from evaporation on Laramie Plains is equal to or greater than the proposed diversion by the Greeley-Poudre Irrigation district from the Laramie River. This proposed diversion, under the present construction, I stated is about 56,000 acre feet per annum in normal years. 60,000 acre feet per annum I calculated to be the unnecessary loss and waste of water by methods employed on Laramie Plains.

3576 Amount of evaporation from wet surfaces is rather surprising. Mr. Samuel Fortier, who is at head of the Bureau of Irrigation Investigation of the United States Government, in Bulletin 117 at page 46; says:

"The table shows that the loss of water by evaporation from heavily irrigated orchard soils while the surface is quite wet, may amount to over four inches per week or double that from the surface of water similarly situated and two feet deep. The loss from soils containing sufficient moisture in the top layer to nourish a vigorous growth in orchards is about one inch per week. Soils that are fairly dry on top lose about one-quarter inch per week. This indicates that the evaporation from wet ground may be even more than from water surface."

So that, those wet areas, if kept wet the year around, might easily evaporate fully as much as though they were actually exposed water surfaces.

If Wyoming appropriator would eliminate the unnecessary waste in Laramie Plains region alone, it would result in a saving of more than enough water to supply the entire diversions of the Greeley-Poudre system from the Laramie River.

Wind has the effect of increasing the evaporation from exposed water surfaces. I have made a quotation from the book of H. M. Wilson entitled "Irrigation Engineering" in which he states that evaporation experiments show that wind of velocity of 30 miles an hour gives 6.3 times more evaporation than in quiet air from lakes and reservoirs. This will give an idea of what a great influence the movement of air in contact with water has on evaporation.

Examination by Mr. Fred Farrar:

I quoted from Bulletin published by Experiment Station of Wyoming to effect that best results were obtained by using 20
3577 acre inches for irrigation of field peas. Field peas are used for feeding sheep, lambs and cattle, for fodder.

The Laramie Plains have better natural facilities for storing of water than exist in the Poudre Valley. The reservoir basins on Laramie Plains are larger, will contain more water and the inlet ditches are not as long nor as difficult of construction. The basins

on the Laramie Plains are fully as numerous as those in the Poudre Valley. Basins on Laramie Plains lying rather high and ditches taken from the bottom of these reservoirs cover a considerable territory. The Wheatland Reservoir No. 2 is very unique, being a very large reservoir and one which was very economical to complete. The same is true of Lake Hattie and Lake James. The Hutton and Creighton Lakes are natural basins, and it would require very little work to convert these into useful reservoirs for irrigation purposes.

There are, as I have stated, numerous small depressed areas in Laramie Plains throughout the area which might be farmed, that is, which lie under canals which would be available for collecting of waste and seepage water and from which water could be withdrawn without great expense for use on lands lying below. Reservoirs on
Laramie Plains, in my opinion, would not seep as much
3578 probably as they do in the Poudre Valley. The soil in these
depressions in Laramie Plains seems to be such as to make it quite impervious. Reservoirs seep very little and it is this character of soil which holds water without its sinking into ground and so by that means come back to river but is held on surface and there evaporated.

Assuming three principal factors going to make successful reservoir construction, that is, first, water supply; second, mechanical construction and third, location with respect to sources of water supply and land to be served, except with respect to cost, there is very little marked difference between the Poudre Valley and the Laramie Plains. But in regard to cost, cost on Laramie Plains is very much less and size of reservoirs is much greater. There are no reservoirs in Poudre Valley to compare in size with Wheatland Reservoir No. 2 or Lake Hattie. In Poudre Valley, Windsor Lake is one of the largest and its capacity is given as 17,689 acre feet. Fossil Creek Reservoir is next largest and derives its supply from the Poudre River and has capacity of 12,050 acre feet. Timnath Reservoir, which is considered very large and valuable, has a capacity of 8,309 acre feet. Terry Lake, one of most noted lakes in Poudre Valley, has capacity of 7,461 acre feet. Halligan Reservoir, which has been completed within last two years, and which is in channel of North Poudre River with a masonry dam about 100 feet high, has capacity of 6,408 acre feet. The combined capacities of all of reservoirs which I have named, which are the
largest of the valley, are not equal to the capacity of Lake
3580 Hattie alone. While I am not familiar with the exact
cost of the reservoirs in the Poudre Valley, I will state that the cost was very much higher on those reservoirs, particularly on Halligan Reservoir, than on Wheatland No. 2 Reservoir or on Lake Hattie Reservoir. The Fossil Creek was also more expensive. It cost more money to construct the Windsor Reservoir than it did the Wheatland No. 2 Reservoir. The matter of rip rap as well as construction of the dike itself has been a matter of considerable expense.

3580 W. L. PETRIKIN, recalled.

Direct examination by Mr. Delph E. Carpenter:

I have with me additional information requested for counsel for plaintiffs at former examination. This information is in form of statement; a tabulation. It is part of tabulation from which I read at previous testimony. I have simply added new information.

(Defendants' Exhibit 146, tabulation, offered in evidence.)

Exhibit 146 is statement I just referred to as a tabulation. Data therein appearing is obtained from records of The Great Western Sugar Company. This statement and tabulation is correct according to those records. Tabulation is as follows:

3581

1902.

	Eaton.	Greeley.	Windsor.	Ft. Collins.
Acreage	3,534	3,750	.....	.....
Tonnage	30,062	37,958	.....	.....
Paid to Farmers	150,226.84	170,810.02	.....	.....
Sugar, per Acre	1.27	1.47	.....	.....

1903.

	Eaton.	Greeley.	Windsor.	Ft. Collins.
Acreage	5,759	4,634	3,234	6,669
Tonnage	47,895	47,922	40,128	67,536
Paid to Farmers	242,236.86	212,950.86	196,432.70	310,039.88
Sugar, per Acre	1.25	1.62	1.94	1.66

1904.

	Eaton.	Greeley.	Windsor.	Ft. Collins.
Acreage	2,851	3,478	3,005	6,018
Tonnage	34,705	45,516	29,517	78,731
Paid to Farmers	173,977.59	227,581.16	147,602.47	*393,653.45
Sugar, per Acre	1.89	2.22	1.63	2.15

* Approximate.

1905.

	Eaton.	Greeley.	Windsor.	Ft. Collins.
Acreage	4,683	8,083	5,449	10,023
Tonnage	61,180	76,587	69,039	120,405
Paid to Farmers	305,901.72	382,931.19	345,198.61	602,033.66
Sugar, per Acre	1.92	1.41	1.91	1.81

1906.

	Eaton.	Greeley.	Windsor.	Ft. Collins.
Acreage	5,892	8,080	5,933	11,062
Tonnage	101,920	111,750	94,160	157,660
Paid to Farmers	511,362.59	562,029.84	471,312.94	789,597.37
Sugar, per Acre	2.59	2.10	2.47	2.24

3582

1907.

	Eaton.	Greeley.	Windsor.	Ft. Collins.
Acreage	4,227	10,810	6,728	13,580
Tonnage	66,449	128,218	90,066	162,336
Paid to Farmers	335,072.98	650,650.22	457,094.11	623,870.79
Sugar, per Acre	2.66	2.11	2.37	2.08

1908.

	Eaton.	Greeley.	Windsor.	Ft. Collins.
Acreage	5,187	8,613	7,182	14,682
Tonnage	61,228	85,480	79,930	143,676
Paid to Farmers	310,278.94	434,523.21	406,268.57	724,140.98
Sugar, per Acre	1.67	1.51	1.59	1.34

1909.

	Eaton.	Greeley.	Windsor.	Ft. Collins.
Acreage	5,136	10,532	6,721	15,622
Tonnage	61,421	99,092	66,263	154,270
Paid to Farmers	312,914.64	505,405.92	337,908.63	785,280.96
Sugar, per Acre	1.79	1.48	1.46	1.41

1910.

	Eaton.	Greeley.	Windsor.	Ft. Collins.
Acreage	4,081	5,384	5,248	8,018
Tonnage	51,886	65,515	64,285	73,090
Paid to Farmers	284,205.33	361,182.56	351,681.94	392,215.27
Sugar, per Acre	2.05	2.01	1.95	1.43

1911.

	Eaton.	Greeley.	Windsor.	Ft. Collins.
Acreage	4,501	6,340	4,908	8,087
Tonnage	61,930	84,487	58,446	88,131
Paid to Farmers	336,696.77	474,106.37	320,883.07	487,957.41
Sugar, per Acre	2.19	2.21	1.90	1.78

2585

1912

	Eaton.	Greeley.	Windsor.	Ft. Collins.
Acreage	10,451	10,089	10,326	12,348
Tonnage	160,965	121,727	138,931	149,232
Paid to Farmers	958,444.73	739,253.91	821,364.27	875,478.83
Sugar, per Acre	2.55	2.05	2.20	2.01

1913.

	Eaton.	Greeley.	Windsor.	Ft. Collins.
Acreage	16,597	11,489	13,401	14,392
Tonnage	217,889	137,484	172,876	158,174
Paid to Farmers	*1,237,945.36	*778,215.60	*975,819.89	*875,698.72
Sugar, per Acre	2.04	1.84	1.97	1.69

* Total of 4 factories.

1910.

Number Laborers	3,247		
Number Factory Employes	987		
No. of Livestock fed on by-products (Cattle)	12,168		
Tons Pulp Sold	60,841		
Avge. Price per ton	.65		
		Local.	East.
Tons Molasses Sold	3,775	2,004	1,771
Avge. Price per ton	10.53	8.99	12.27
Tons Sugar Sold	31,326		
Avge. Price per ton	$90.30		

1911.

Number Laborers	3,405		
Number Factory Employes	1,012		
No. of Livestock fed on by-products (Cattle)	14,223		
Tons Pulp Sold	71,118		
Avge. Price per ton	.67		
		Local.	East.
Tons Molasses Sold	4,527	2,435	2,092
Avge. Price per ton	$7.59	7.62	7.55
Tons Sugar Sold	37,792		
Avge. Price per ton	$103.44		

3584 1912

Number of Laborers	6,173		
Number Factory Employes	1,031		
No. of Livestock fed on by-products (Cattle)	26,597		
Tons Pulp Sold	132,985		
Avge. Price per ton	.60		
		Local.	East.
Tons Molasses Sold	4,534	3,003	1,531
Avge. Price per ton	7.46	6.67	9.01
Tons Sugar Sold	67,864		
Avge. Price per ton	$81.43		

1913.

Number of Laborers	7,982		
Number of Factory Employes	1,087		
No. of Livestock fed on by-products (Cattle)	*28,820		
Tons Pulp Sold			
Avge. Price per Ton			
		Local.	East.
Tons Molasses Sold	10,937	6,903	4,034
Avge. Price per ton	8.20	7.75	8.97
Tons Sugar Sold	73,097		
Avge. Price per ton			

*Estimated.

On Exhibit 146 after the heading "Tons Molasses sold" appear two words "Local" and "East" as heading two columns on right hand side of sheet. "Local" refers to tonnage sold to feeders in locality immediately adjacent to factories and term "East" refers to amount that was shipped to eastern manufacturers, and same applies to price per ton as to local and east.

Figures given under headings "Tons pulp sold," "Average Price per ton," "Tons Molasses Sold," "Average Price per ton," "Tons Sugar Sold," "Average Price per ton," include production from Eaton, Greeley, Windsor and Fort Collins factories. For
3585 illustration, where after title "Tons Pulp Sold," 1910, the figures 60,841 appear, that represents total number tons of pulp sold for four factories that year. Same obtains throughout tabulation.

Under year 1913 word "Estimated" with star indicating reference

to figures 28,820 as number of livestock fed on by-products for year 1913, represents number of cattle that could be and presumably were fed on total tonnage produced at the four factories mentioned. It is an estimated amount. Total number of livestock fed on by-products refers to cattle throughout tabulation.

Figures included under any one year, for illustration 1910, all pertain to beets raised in year 1910, for instance tons pulp sold which is given as 60,841 tons, is pulp sold from beets raised in 1910.

3586 Value of by-products obtained for sugar factories can be compared in a general way with products of agricultural lands in this way:—I have a number of times made and am now willing to make, on account of having been connected with live stock end of the company, the statement that after an acre of sugar beets has produced on an average of 3,000 pounds of human food, we still have by-products equal to average acre of corn in State of Iowa in 1913, which was 43 bushels to acre, for production of livestock. This includes pulp, molasses and beet tops.

An acre of sugar beets produces by-products equal to an average acre of corn in Iowa, insofar as production of livestock is concerned.

Growing season in Cache la Poudre Valley is not unnecessarily long for sugar beets. I know of no territory where there is a season unnecessarily long, but I can say that it is not too long. Whether or not all of the growing season is required for the profitable growing of sugar beets in that vicinity is only comparable with the degree of profit. The entire growing season is utilized in growing of sugar beets in that valley.

I know of no territory having a shorter growing season than what I term northern Colorado, where sugar beets can be grown with security and profit sufficient to grower to justify continuation of the industry.

3587 I would consider it hazardous at present price of the raw product, to attempt to grow sugar beets in a region having a growing season thirty days later in spring and from two weeks to thirty days earlier in fall than the season in the Poudre Valley and having much lower temperatures during the growing season than in that valley. The production of sugar beets would at least be very materially decreased per acre.

Cross-examination by Mr. N. E. Corthell:

These figures which I have given cover entire history of sugar beet industry in Cache la Poudre Valley District, with exception of year 1901 of which I do not have data to supply the information. Just one factory, Loveland, was in operation that year. None of these factories were in operation in 1901. So far as this district is concerned, and these four factories, this covers entire history of their operation. Prices given by me in this table are net cash prices at factories.

3588 JOHN E. FIELD, recalled:

Direct examination by Mr. Delph E. Carpenter:

The lakes which are mentioned in connection with my testimony of enormous waste of water occasioned by present methods of irrigation prevailing in Laramie River drainage area will of necessity finally be drained and the wasting of water into them will be prevented. The land will be reclaimed.

Seeped lands in Poudre Valley have been reclaimed to large extent. Water drained from those lands is utilized by other ditches, in some cases it has been sold, in other cases it has been developed for the use of the water itself and reclamation of land has been an incident to the work. Object in many cases has been to secure water.

3589 Reclamation of wet lands and recapture of waste and seepage water greatly increase the duty of water used in terms of original water in Poudre Valley. Same thing will result when Laramie Plains people realize necessity of water, whenever there is a scarcity the reclaiming of water will be brought about. Some of those natural lakes will be drained and doubtless some of them will be converted into useful irrigation reservoirs, as has already been done with Lake James.

James Lake, prior to construction of irrigation reservoir on that site, was a natural reservoir into which waters flowed and there remained and evaporated to large extent. All the work required to make this water useful, was to build a cut through the rim of the Lake so that the water might be drained off.

On some of the waste water lakes it may be that pumping plants may be installed as they have in northern Colorado and water will be pumped out of them. There are numerous instances in northern Colorado, where water is pumped from natural reservoirs. There is one of which I have been advised, but which I never visited, east of Greeley, where a gasoline pumping plant has been installed for purpose of taking water from Greasewood Lake. I am informed the lift is 70 feet from the water in the lake to the ditch by means of which the water is utilized. This lake is situate about 30 miles northeast of Greeley. In vicinity of what is known as Pawnee Buttes.

3590 Drainage and utilization of this water from these waste lakes on Laramie Plains would not be profitable under present condition of agriculture in valley. There is an abundance of cheap water there, that can be used, and there is an abundance of land and until there is a demand for either water or land, these more expensive developments will not be made. At any rate, this water, under present methods, remains each year subject to re-use if they will only make an attempt. Their failure to re-use this water results in absolute loss to all agriculture.

It is necessary to replenish the water annually by waste or seepage, in order to maintain water in these waste lakes, unless water flows into these lakes, and unless a water supply is furnished, they

would dry up. Consequence is that there is a constant waste with a constant replenishment throughout each irrigation season.

Running of water through ditches in large quantities during winter season for alleged watering of stock is considered a wasteful use in well established irrigation communities and is not permitted in Colorado, at least. Within the last year or two I have had occasion to shut off domestic supply which was being taken into ditches in winter time and also to close down valves in one channel reservoir and to prevent natural flow from going down the river, notwithstanding it was demanded for stock water purposes by
3591 party living along the creek. These parties thus far have made no provision to substitute the water thus shut from them, but they will ultimately have to provide themselves with reservoirs or wells. Such use is so wasteful that it cannot be permitted. In the particular case of which I speak, for purpose of watering a few head of stock, 25 cubic feet of water per second was required to pass down channel of the river and that water was entirely lost for irrigation use. I consider it a very wasteful use and for that reason we had the valves of the reservoir closed down and permitted the reservoir to store the water. This was during winter months.

Where water is run from river through ditches in other than irrigation season, it is returned as soon as possible to the stream. Our laws in Colorado require that it be returned to stream at highest point practicable.

Any appropriator would have a right to complain if other appropriators ran water from stream to ditches for alleged stock use and then wasted it into sinks and waste lakes from which it had but one final outlet, evaporation. He could invoke services of water commissioner to prevent that waste. Such practice would not be tolerated under Colorado police administrations of streams where there was scarcity of water.

Mere digging of shallow wells throughout most any irrigated region, will afford sufficient water for livestock.

3592 Largest U. S. Reclamation Service canal, construction of which I supervised, is called The Interstate Canal, heads in North Platte River in Wyoming and was designed to cover 160,000 acres of land. In designing that canal, I provided for a maximum carrying capacity of 1,400 cubic feet per second, which amount would meet maximum demand and meet peak load. That would mean that the maximum demand under that system would be one cubic foot for 115 acres.

On Orchard Mesa Project in western Colorado, on which I was consulting engineer, we made plans which provided for one cubic foot of water for each 120 acres. This project is located near Grand Junction, where rainfall is only 8 inches on average and about the same as it is in Laramie Plains, although temperatures there are very much higher and the seasons are considerably longer.

Also designed and constructed canal in San Luis Valley at altitude of about 7,500 feet. Project included about 34,600 acres. Capacity as designed for main canal was 300 cubic meet per second or 115 acres per cubic foot per second.

Wyoming unit of 1 cubic foot per second for 70 acres would meet greatest demand for any kind of crop or any kind of
3593 soil and would represent only those conditions where maximum amount of water was necessary. It is probable that there are districts where that amount of water measured at headgate, for service of land, might be necessary and not unreasonable. But as a general rule, I would consider that very low duty, unnecessarily low. But, as law was formed to meet most adverse conditions, very properly they fixed maximum at 70 acres for one cubic water per second of time. This unit refers to a flowing stream of one cubic foot per second.

The Interstate Project of the United States Reclamation Service was completed. Experience of use of water on that project was that the water seems to have been too abundant. A great deal of the land has become seeped and wet. Drainage has become necessary. With a less use of water, I think there would not have been so much land destroyed and made useless by reason of this seepage. Not so much of it would have become wet. The Reclamation Service has contracted to furnish 2½ acre feet per annum on this project and they have found it difficult to get users to use less water than the amount which contract calls for, there being a tendency here, as in all other cases, on part of irrigator, to take all water he can get and difficulty and destruction of land by reason of seepage has not yet ceased. During past season, average use of water on this project was 2 acre feet per acre, notwithstanding that users under their contract were entitled to 2½ acre feet. If more water, as I understand the contract, is used than 2½ acre feet per acre there is additional charge. A great many use their full amount and some use more than the contract calls for and pay for additional water, but, notwithstanding this extra use, as I said, on project as whole use of water dur-
3594 ing past season was 2 acre feet per acre. This use of water was on practically new partially developed land. The project is not old.

I know it is the desire at present, to still further limit quantity of water used in order to prevent further spreading of this seepage territory. The Reclamation Service has inaugurated a drainage system.

Excessive use of water in Nebraska under the Reclamation Service project has produced practically same results as it did on Laramie Plains under Pioneer Canal.

Obtaining a higher duty of water results in reclamation of more acreage without necessity of diversion of greater quantity of water from stream. Present methods of irrigation in Little Laramie Valley are very wasteful. In event crop returns from the land in that region would warrant any expenditure of money for further development, channels of stream there should be straightened and provision should be made for drainage of wet water-logged areas and provision should be made for returning surplus water, if any remains in ditches, to stream as early as possible. The running of water out on land in winter time and permitting that waste from exaporation, of course would cease.

It happens, that in those districts where best and most extensive agricultural development has occurred, there is a shortage of water. Complaints of shortage come with lack of water.

Usual consequence of superabundance of water supply is that land is overirrigated and that considerable areas become seeped and alkalied. It is a fact that average farmer, up to time he becomes skilled in use and application of water, is inclined to demand more water than he really needs and to take it whenever it can be obtained. Absence of complaint of shortage in better irrigated districts is on account of better administration. Where there is abundant water, there is a tendency to let everybody take water as he pleases. The neighbors of course disagree and fight over water, where if well administered, water commissioner keeps things straightened out and prevents neighborhood quarrels. I think in Poudre Valley itself, there is less conflict and controversy today than in the seventies, but I attribute absence of those conflicts to administration.

3595 In communities where there is an abundant water supply, there is usually a tendency to take more water than farmer really needs. The irrigator always, it seems to me, is demanding more water than he really needs. That seems to be a trait of human character which comes with irrigation.

Speaking of diversion of water from one natural drainage area for application upon land situate within another and foreign natural drainage area, in irrigated regions the custom is to go and get water where you can get it, whether it is from same water shed in which land is situated or whether it is from some other water shed.

Inter-water shed diversions are made where necessity arises that will justify construction. As a rule they are decidedly more expensive than intra-water shed diversions. As a rule, only obstacle is that of expense. Whenever there begins to be a water shortage, the irrigators or those desiring to build ditches or desiring to increase efficiency of their systems, look for other water supplies and this search for additional water carries them into other water sheds, and, if not too expensive, these diversions are made.

Future possibilities of development within drainage area from which water is diverted and taken are not taken into consideration as a rule in making or permitting these inter-water shed diversions. Future needs of district from which water is taken are never considered. Projectors of inter-water shed diversions simply ascertain whether there is any water there sufficient for them. Their necessities have come earlier than the necessities of those in the drainage area itself, and are supplied first, and they take their water in order of priority regardless of whether it is to be used in the same water shed or in a different water shed.

Rule of appropriation by priority, rather than rule of riparian rights, prevails within the boundaries of the jurisdiction of the several arid states.

3597 I have taken occasion to ascertain conditions relative to inter-water shed diversions in several of the arid states. I had intended to make detailed investigation of matter of diversion of water from one water shed to another, but in press of other work

that was principally assigned to Professor Carpenter, but, prior to that time I had written to state engineers of different states in arid region to ascertain the practice and custom in those states. I refer particularly to those states known as appropriation states, in other words, states where riparian doctrine does not prevail.

Such a letter was written to state engineer of Utah.

(Defendants' Exhibit 147, copy of letter to state engineer of Utah, identified and offered in evidence.)

This is copy of letter which I sent to State Engineer of Utah and is same as the letters which I sent to other state engineers. I sent this uniform letter to each state engineer. The letter reads as follows:

"STATE OF COLORADO,
ENGINEERING DEPARTMENT,
DENVER, Aug. 15th, 1913.

John E. Field, State Engineer.
A. F. Hewitt, Deputy.

State Engineer, Salt Lake City, Utah.

DEAR SIR: I am making an investigation of the extent of diversions of water from one watershed to another. I have divided such diversions into three classes:

1. Diversions across the Continental Divide.
2. Diversions from one main drainage to another.
3. Diversions of water from tributary stream where water is carried into the watershed of other tributary streams of the same general drainage area.

To illustrate: Of the first class would be diversions from the head of Eagle river in Colorado to the head waters of the Arkansas river, and from the head waters of the Grand river to the head waters of tributaries of South Platte river. Of the second class would
3599 be diversions from the Laramie river to the Cache la Poudre, the waters of both of which streams ultimately join at junction of North and South Platte rivers. Of the third class would be diversions from Big Thompson river in Northern Colorado to the Cache la Poudre, and vice versa, or from Clear Creek to Bear Creek, all these streams being tributary to the South Platte river.

I write to ask whether such diversions are permissible in your state, and if so, whether there is any distinction in permissibility affecting the three classes.

If possible, I wish you would give me from your records as complete a list as practicable of all such diversions which are being affected in your state in any of the three classes. I realize that the enumeration of the diversions of the third class would probably be very extensive indeed, in which case, a general statement to the effect that such diversions were common would meet my purpose. I would like, however, to have you give any instance of diversions between main watersheds; that is, those diversions coming under the first and second classes.

Any extra expense entailed upon your office by furnishing me with this data, I will gladly pay. Pending the sending of this list, I wish you would write me whether such diversions are permissible or common in your State.

I fully realize that I am asking considerable, and can only say that upon your request I shall be glad to furnish any information concerning this State which might be of interest or of use to you.

Yours truly,

(Signed) JOHN E. FIELD,
State Engineer."

3600 I sent letters identical with Exhibit 147 to the State Engineers of New Mexico, Nevada, Idaho and to Commissioner of Irrigation of Alberta, Canada. Received reply to my letter Exhibit 147, from State Engineer of Utah.

(Defendants' Exhibit 148, letter, three sheets, State Engineer Utah, identified and offered in evidence.)

Exhibit 148 is reply to my circular letter to State Engineer of Utah. There are two letters, one dated August 19 and one September 19 and third sheet comprises tabulated statement of inter-watershed diversions in State of Utah. This table is referred to in letter of September 19, 1913. The letters and tabulated statement are as follows:

Office of W. D. Beers.
State Engineer.
Salt Lake City, Utah.

August 19, 1913.

Hon. John E. Field, State Engineer, Denver, Colorado.

DEAR SIR: Your communication of the 15th inst., in which you ask for certain information relative to diversion of water from one drainage area to another, at hand. In reply will state that it is permissible in this state to divert water from one main drainage area into another, and also from the watershed of one stream into the watershed of another stream when both are tributary to the same drainage area.

3601 Regarding the classifications which you make will say that we have no diversions across the continental divide in this state. The diversion of water under classifications two and three, as outlined in your letter, are quite common within the state, but at the present time we are so rushed with work that I will have to postpone giving you this information in detail until such time when the work in the office will permit me to give the matter more attention.

Trusting that the above information will be satisfactory, I remain,

Respectfully yours,

(Signed) W. D. BEERS,
State Engineer,
By C. J. U.

U./M.

Office of W. D. Beers.
State Engineer.
Salt Lake City, Utah.

Sept. 19, 1913.

Hon. John E. Field, State Engineer, Denver, Colorado.

DEAR SIR: In accordance with our letter of August 19, I am enclosing herewith list of diversions from one main drainage area into another. As stated in our letter of that date, we have no continental diversions within this state.

Regarding the diversions of water from tributary streams, where water is carried into the watershed of other streams of the same general drainage area, will say that such diversions are quite numerous in this State. I have not made a detailed list of same, as your letter of August 15 asked us to only make a statement as to whether such could be done or not.

Trusting that the enclosed information will be satisfactory and of value to you, I remain,

Respectfully yours,

(Signed) W. D. BEERS,
State Engineer,
By C. J. U.

U./M.

(The list of diversions mentioned in the above letter will be found on the following page.)

(Here follows paster, marked page 3603.)

Water Diversions from One Main Drainage Area to Another, as Shown by the Records in the State Engineer's Office, Salt Lake City, Utah.

Application No.	Applicant.	Quantity of water diverted.	Purpose.	From		To	
				Stream.	Drainage area.	Stream.	Drainage area.
944	Timpanogas Irr. Co.....	7,500 acre ft.....	Irrigation	Shingle Cr. & Beaver Cr...	Weber River	Provo River	Utah Lake—Jordan R.
79 & 3563	U. S. Reclamation Service..	160,000 acre ft.....	Irrigation	Strawberry R. & Tributary.	Green River	Spanish Fork River...	" " "
1929	Jos. R. Murdock.....	2,000 acre ft.....	"	Beaver Creek.....	Weber River	Provo River	" " "
3510	Knight Power Co.....	50 sec. ft.....	"	Duchesne River	Green River	" "	" " "
°3519	" " ".....	" " ".....	Power	"	" "	" "	" " "
		1,000 sec. ft also					
4020	Burt & Carlquist.....	60,000 acre ft.....	Irrigation	Weber River	Weber River	" "	" " "
4244	Nephi Johnson	500 acre ft.....	"	Joes Valley Branch.....	Green River	Ephraim Creek	Sevier River.
4397	Thomas R. Cutler.....	2,000 acre ft.....	"	Weber River and Beaver Creek	Weber River	Provo River	Utah Lake—Jordan.
3124	N. T. Porter.....	30 second ft.....	"	Duck Creek, Duck Lake, Swaine Creek	Sevier River	Kanab Creek	Colorado River.

° Withdrawn.

3903 NOTE.—No. 79 & 3563 are the only ones in which the diversion has actually been accomplished; all others are proposed or in process of construction.

3604 Received answer to my communication, similar to Exhibit 147, addressed to State Engineer of Nevada.

(Defendants' Exhibit 149, letter State Engineer Nevada, identified and offered in evidence.)

Exhibit 149 is answer to my circular letter to State Engineer of Nevada. It reads as follows:

"State of Nevada.

Engineer's Office.

W. M. Kearney, State Engineer.
Seymour Case, Assistant.
R. A. McKay, Chief Clerk.

CARSON CITY, Aug. 21, 1913.

Subject: In replying, refer to—

Mr. John E. Field, State Engineer, Denver, Colo.

DEAR SIR: I have your letter of the 16th inst., in which you refer to the practice in this state regarding the allowance of diversions from one drainage area and between tributaries lying in the same drainage basin.

The Continental Divide does not affect Nevada, hence, we have no diversion of the first class mentioned in your letter.

Diversions of the second class are permitted and the most striking example of a diversion in this class, is the Truckee-Carson Canal, diverting water from the Truckee River near Wadsworth, Nevada, and carrying the water to the Carson River Drainage Basin, a portion of which water is to be stored in what is known as the Lahontan Reservoir site in the bed of the Carson River. This Canal was constructed by the United States Government in 1903.

Other diversions from the drainage basin of the Truckee River, at its head, exist, though the diversions are small and were constructed several years ago and this office has not a complete record of them. For instance, the Carson & Tahoe Lumber and Fluming Company diverted water from the drainage basin tributary to Lake Tahoe and discharged it into the Carson River drainage basin. Lake Tahoe is the head of the Truckee drainage basin. The Virginia City Water Company are now diverting water from Marlette Lake and its tributaries, within the Truckee drainage basin above Lake Tahoe, to Virginia City, discharging the surplus into the Carson drainage basin.

There are old ditches diverting water from Walker River drainage basin into the Churchill Valley, eventually discharging into the Carson River drainage basin. This, however, is confined to the flood season and it might be said that the land lies either in the Walker drainage basin or Carson drainage basin.

Diversions of the third class are quite common. Under the doctrine of appropriation, we hold that the taking of water from one drainage basin to another, so long as it does not interfere with prior

rights, comes within the scope of the doctrine and all such permits are granted as in other cases, where the point of diversion and place of use are within the same drainage basin or within the basin lying adjacent to the tributary from which it is diverted.

Very truly yours,

(Signed) W. M. KEARNEY,
State Engineer.

Dic. K./McK."

3606 Received reply to letter similar to Exhibit 147, sent to State Engineer of New Mexico.

(Defendants' Exhibit 150, letter State Engineer New Mexico, identified and offered in evidence.)

Exhibit 150 is letter from State Engineer of New Mexico in answer to circular letter which I sent him concerning diversion of water from one watershed to another. It reads as follows:

State of New Mexico,
Engineering Department,
Santa Fe.

James A. French, State Engineer, Member State Highway Commission.

September 15, 1913.

Mr. John E. Field, State Engineer, Denvor, Colo.

3607 DEAR SIR: Replying to your letter of August 16th, in regard to diversions across the Continental Divide, and from one main drainage area to another, and diversions from tributary streams where water is carried into the watershed of another tributary streams of the same general drainage area—I wish to state, after an examination of the records here the results are as follows:

1. Diversions across the Continental Divide:

There have been no such diversions in this state. Diversions from the headwaters of the Rio Grande to the San Juan are not allowed, if they were possible, since the U. S. Reclamation Service has a blanket filing on all the waters of the Rio Grande except for small individual appropriations of not over 1,000 acre feet per annum. Again the waters from the San Juan to the Rio Grande could not be so diverted at present, since they are in litigation on the San Juan.

2. Diversions from one main drainage to another:

There are none in this state that we know of coming under this head, and our law as backed by the Attorney General's decision holds that water cannot be diverted from New Mexico to use on lands in another state as long as the water can be put to use in New Mexico.

3. Diversion of water from tributary streams where water is carried into the watershed of another tributary stream of the same general drainge area.

The only example of this we can find of record is an application on file by the Farmers Development Company, No. 770, which is to

divert from Urraca river over into an Arroyo of the same drainage and thence to be carried to the storage reservoir. This application has been protested upon the grounds that there is not unappropriated water to supply the said permit.

If further information is desired, please advise me.

Very truly yours,

(Signed) JAMES A. FRENCH,
State Engineer.

J. A. F./W."

3608 Received reply to letter, similar to Exhibit 147, addressed to State Engineer of Idaho. This reply consisted of two letters, one dated August 19, and one September 12.

(Defendants' Exhibit 151, consisting two letters State Engineer Idaho, identified and offered in evidence.)

Exhibit 151 consists of two letters from State Engineer of Idaho. These letters are in answer to my inquiry concerning inter-watershed diversions. They read as follows:

State of Idaho,
Engineering Department,
Boise.

F. P. King, State Engineer.
Herbert Wing, Deputy State Engineer.
W. R. Heyde, Chief Carey Act Engineer.

BOISE, IDAHO, August 19, 1913.

Re Change of Water Shed.

3609 Mr. John E. Field, State Engineer, Denver, Colorado.

SIR: Replying to your letter of the 16th inst., in the above would say that Section 3244 of the Revised Codes of Idaho reads as follows:

"The water appropriated may be turned into the channel of another stream and mingled with its water and then reclaimed, but in reclaiming it the water already appropriated by another must not be diminished."

This section is 3158 of the Revised Statute- of 1887 and is in the same language as the California Civil Code of 1872, Section 1413.

I cannot at this time cite you any cases involving the question raised in your letter, except the case of Walbridge vs. Robinson, 22 Idaho, 236, 125 Pac. 812, 43 L. R. A. Page 240, which involves the question of the appropriation of water in Idaho to be diverted and used in a sister state.

Very truly yours,

F. P. KING,
State Engineer,
By WING.

W./G.

State of Idaho,
Engineering Department,

Boise.

F. P. King, State Engineer.
Herbert Wing, Deputy State Engineer.
W. R. Heyde, Chief Carey Act Engineer.

BOISE, IDAHO, September 12, 1913.

Re Transfer of Water Rights from One Watershed to Another.

Mr. John E. Field, State Engineer, Denver, Colorado.

SIR: Replying to yours of the 25th ult., would advise that just at present I cannot recall for purposes of identification the numbers of permits involving a transfer of water from one shed to another but I know that such action has been taken repeatedly, without question.

Very truly yours,
(Signed) HERBERT WING,
Deputy State Engineer.

W./G.

3610 Received reply to my letter, similar to Exhibit 147, addressed to Commissioner of Irrigation of Alberta, Canada. It consists of a letter of two pages, of a tabulation and of a sketch map, being four pages in all.

(Defendants' Exhibit 152, letter of four sheets Commissioner of Irrigation Alberta, Canada, identified and offered in evidence.)

Defendants' Exhibit 152 is letter writted by Commissioner of Irrigation of Alberta, in answer to my circular letter to him concerning inter-watershed diversions. The first three sheets of the exhibit read as follows:

3611 "Department of the Interior,
Irrigation Office.

Please address your reply to The Commissioner of Irrigation, Department of the Interior, Calgary, Alta.
Refer to File 1285.
C./P.

CALGARY, ALTA., August 25, 1913.

SIR: I beg to acknowledge receipt of your letter of the 16th inst. regarding the diversion of water from one watershed to another.

I am attaching hereto for your information schedule showing all of these diversions in so far as I am able to discover from our records. I would state in explanation that this matter has not been as difficult a one, nor entailed as much labour as you anticipate, because of the fact that diversions of this character in Western

Canada are not general, and I think that you will find the list submitted quite complete.

Regarding the class 3 diversion, there is only one case, as you will note, and this is possibly explained by the fact that the amount of water in our smaller streams is unusually small as compared with the amount of land which can be easily irrigated lying in the valleys of these creeks, and therefore, when nearly all the valley land of any particular creek had been irrigated, there was usually no water left to irrigate other lands with.

As you are probably aware, our laws in this respect are very strict and when this office considers that the appropriations on any stream are such as will use up the amount available, we do not allow any other appropriation on this stream in order that the
3612 water rights which have been granted may be absolutely protected.

If this information is not just what you want or if there is anything else you would like to know, I would be very glad indeed to give you the information if you will communicate with me again.

Your obedient servant,

(Signed) P. M. SANDER,
Acting Commissioner of Irrigation.

Class 1. Continental Divide Diversions, Canadian Pacific Railway Company Irrigation scheme near Lethbridge, Alberta, to divert water from the St. Mary river, Hudson Bay drainage and some of the waste water will run back into Pakowki lake drainage basin (no outlet) which lies in the Milk river drainage area, which is tributary to Missouri river and hence Mississippi river.

With some extension of the above ditch a considerable amount of water might go directly to Milk river drainage area.

Under terms of International Waterways Treaty, U. S. Reclamation Service is diverting water directly from St. Mary river, Hudson Bay drainage into Milk river, Missouri river drainage. (See Milk river project.)

Class 2. Main drainage area to another. Canadian Pacific Railway Company, western section, near Calgary, Alberta, diverts from Bow river into drainage of Red Deer river.

Canadian Pacific Railway Company, Lethbridge system, diverts from St. Mary river to Belley river.

Southern Alberta Land Co. near Medicine Hat, Alberta, diverts from Bow river into Belley river.

Province of Alberta, near High River, Alberta, diverts from
3613 Highwood river, tributary to Bow river, into Little Bow river, tributary to Belly river.

Sketch.

Class 3. Diversions from Battle creek to Middle Creek, both flowing into Milk river."

I sent a letter similar to Exhibit 147 to State Engineer of California. I received a reply to that letter.

(Defendants' Exhibit 153, letter two sheets State Engineer California, identified and offered in evidence.)

Exhibit 153 is letter from State Engineer of California in answer to my circular letter to him concerning diversions of water from one watershed to another. State of California is what is known as one of the states adhering to doctrine combining both doctrine of appropriation and doctrine of riparian rights. The letter consists of two sheets and reads as follows:

"Address all Communications to

Department of Engineering.

W. F. McClure, Engineer.
Earle Freeman, Secretary.
J. W. Wollett, Architect.
Jerome Newman, Paul M. Norboe, Assistant Engineers.

State of California,
Department of Engineering,
Sacramento.

August 21, 1913.

3614 The State Engineer, Honorable John A. Field, Denver, Colorado.

DEAR SIR: Replying to your inquiry of the 16th inst:

There is no law on the statute books affecting diversion from one watershed to another.

While there is no diversion of watersheds by the Continental Divide, the division between the Great Basin and the coastal drainage areas is similar. The great Los Angeles Aqueduct diverts from the streams of the Great Basin, crosses over and through the Main Divide to the Coast, and its right to do so has not been questioned.

Also the diversion from Hetch-Hetchy Valley to San Francisco might be construed as coming under your second class, though as a physical fact the Hetch-Hetchy water finally reaches San Francisco Bay in its natural course.

Permit me to suggest a case similar to yours in Montana. A portion of the water supply of Butte is pumped from Big Hole River, a tributary of the Missouri, crosses the Continental Divide to Butte, on the Pacific Slope.

There are many diversions in this state of the third class you describe.

California law has taken no cognizance of the different classes, though it may have been defined by some decision of the Court, not recalled by the writer.

Referring again to your second class: The U. S. Reclamation

Service controls to a certain extent the outflow of water from
3615 Lake Tahoe. The lake is mostly in California, about 1/3 of its surface lying in Nevada. Nearly all of its watershed is in California as is also the outlet—Truckee River, which flows into Nevada and terminates in Pyramid Lake. The Service has diverted the entire flow into the Carson River Basin for irrigation under the Truckee-Carson Project, so that this year no water is running into Pyramid Lake, according to news dispatches.

Since this State's control over diversions is so limited, no comprehensive list is made, but if citation of a few specific cases of class three will serve you better than the statement that cases of that class are numerous, effort will be made to supply them.

Very truly yours,

STATE DEPARTMENT OF ENGINEERING,
By P. M. NORBOE,
Assistant State Engineer."

PMN/HB

These letters Exhibits 148 to 153 inclusive, confirm statements already made to effect that inter-watershed diversions are generally practiced in each of several states covered by these communications.

JOHN E. FIELD.

3615 Cross-examination by Mr. John D. Clark:

My first visit to the Laramie Plains was a short trip in 1903. In 1910 I was there two or three days to examine the River-
3616 side ranch, and I was there the next time in 1913. In the intervening years I was at Wheatland a number of times. In May, 1913, I spent a week upon the Laramie Plains and in the Wheatland District. In June I was over the Laramie Plains for about a week, for five days in July and once in August, and after the commencement of the taking of testimony in this case I made a number of trips over it. Some of the trips were to
3617 supervise the surveyors who were making the plane table survey under my direction and some were for the purpose of investigating soil and agricultural conditions. My acquaintance with the Poudre Valley since 1890 has been rather close.

3618 The most expensive reservoir constructed in the Poudre Valley is the Halligan, costing $32 per acre foot of capacity, which was completed about two years ago, and I know of no reservoirs now in course of construction of equal cost. The ordinary cost of reservoir construction in the Poudre Valley at the present time is from $10 to $20 per acre foot. The present storage capacity in the Poudre Valley is such that in some years the reservoirs are not all filled, while in some years they are filled and water
3619 runs to waste. The normal amount of water flowing out of the Poudre Valley including seepage water is about 110,000 acre feet per annum. The cost justifiable for a reservoir is largely dependent upon the market value of water at the time. A larger

price could be paid for a supplemental supply to finish out a
3620 partial supply already acquired than if the reservoir water was the only source of supply for the particular tract of land. The value of a water right depends upon the amount of return that can be secured through the use of the water, and this is dependent upon the value of the crops raised.

3621 It would not be possible to inaugurate a scheme in the Poudre Valley to construct reservoirs to store water from one year of high flow to another where such water is the only source of supply, for the reservoirs would have to be constructed to hold the maximum amount, and if the water has to be carried over for three years the average diversion from the reservoir would be only one-third of its capacity, making the cost per acre prohibitive.

3622 The net average return from the crops raised in the Poudre Valley after deducting the cost of growing and harvesting the crops, would vary from $25 to $50 an acre, while the net return from the irrigated lands upon the Laramie Plains would be three or four dollars per acre, based upon the average production of one-half ton of native hay per acre, which is about the average production in that region, and a price as high as $10 per ton in stack. In my opinion the raising of native hay in connection with livestock is the best use to which the land upon the Laramie Plains may be put, although there will, of course, be grain and potatoes raised for local consumption. The use of native hay land upon the Laramie Plains in connection with the
3623 outside range increases the value of the irrigated lands very greatly above the value indicated by the crop production, and in consideration of this circumstance I would consider the market value of those lands to be from $25 to $50 per acre, whereas the market value judging solely from the standpoint of the crops would be from $10 to 25 per acre. A false conclusion would be reached in considering the value of land upon the Laramie Plains without taking into consideration their use in connection with stock raising. The conditions are such upon the Laramie Plains that in my opinion there is little likelihood of the area being divided into small tracts, as it would be impossible for a settler to support himself and his family upon a small area as is done in a better country.

In 1910 I made an investigation of the Riverside Ranch upon the Laramie Plains, spending three or four days in the examination, and prepared a report upon it for the owner, which was in part as follows: "I submit herewith a report on the farm and ranch properties of your company near Laramie, Wyo.

3624 On April 6th, I made a trip to Cheyenne to obtain records, etc., bearing on the subject and on April 24th to 27th I examined the property in company with your engineer, Mr. Robinson.

The features which appeared to require examination were:

1st. The water supply which includes a consideration of the stream flow, the existing rights on the streams in Wyoming, the water rights and prospective irrigation development in Colorado,

and the influence which interstate complications might have on your properties;

2nd. The climate including rainfall, temperatures, frost periods and length of the growing season;

3rd. The crops which will do well in this locality and the probable future character of the produce which will be raised;

4. Allied industries;

5th. Markets;

6th. Values present and prospective."

* * * * * * *

"In the consideration of any project involving the use of water from the Laramie River, the question of interstate rights is vital, for if Colorado, as has sometimes been claimed, has absolute control of all the waters within its borders regardless of the rights of a state into which the stream passes, and its citizens can divert the water to their land to the detriment of other and prior appropriators lower down on the stream and in another state, the rights and the interests of the people of Wyoming will be seriously affected. On the other hand, if priority of use gives the better right regardless of state lines, then the settlers and land owners taking water from the Laramie River in Wyoming will not be affected and the use of water in Colorado may even prove a benefit, unless the water is carried into a different watershed and the return seepage and surplus water does not return to its natural drainage basin. This matter has been in the courts a number of times and has been determined between different states by different courts. So far as I am aware, no decision by any court of last resort has yet been handed down which sets aside the rights as determined by priority of use because the later appropriator was higher on the stream and in a state in which the waters had their origin."

* * * * * * *

"It is hardly necessary, however, to consult the court decisions, as it is unreasonable to suppose that a subsequent appropriator could, by the diversion of water from the stream in another state, destroy the values and property rights of one who, through the expenditure of time and money, had previously created those values and established a home and a business dependent on such water and the enjoyment of the right of its diversion and use.

* * * * * * *

"A number of the Colorado canals take water from tributaries of the main stream and the diversion by them is probably much less than is indicated by the published statement of decrees. This less diversion is also probable from the fact that decrees in Colorado are almost always excessive and many have never been used at all. The capacity of all canals reported on by the Water Commissioner of District Number 48 is given as 563 cubic feet per second out of a total of 1255.8 cubic feet per second, while the irrigable area is given as 4,720 acres, using 57,894 acre feet, or nearly 12 acre feet per acre per annum, an amount obviously wasteful and excessive.

* * * * * * *

3626 "On the Riverside and Hoge farms the duty of water should not be very low, as on the meadows during the high water period, that is, in May and June, there will be a certain amount of subirrigation and overflow. The greatest demand will probably come in July, during which month probably three-fourths of an acre foot per acre will be required, or one cubic foot per second will probably serve about eighty-three acres. The decrees of the Company call for one cubic foot per second for each seventy acres.

The canals serving the land are comparatively short, and the losses proportionately small, and even that which is lost by seepage in transit will be of benefit to the land under which it passes on its way to the river.

In August and September little water will be used, as most of the crops will have been harvested and even the late maturing crops will have begun to ripen and the water will have been taken off of such crops. In all two and one-half acre feet per annum per acre is doubtless an ample supply, and the decrees owned by the Company and the water available in the river will furnish that amount.

* * * * * * *

The soil of the area may be divided into three different classes: They are, First, residual soils formed from the disintegration of rocks in situ; Second, alluvial soils formed from the material deposited in the rivers; Third, alluvial soils formed by the materials carried down from the mountains by the transporting agencies.

The soil of the Laurel Sandy Loam is an alluvial deposit varying from two to six feet in depth. This soil is usually black, although sometimes dark yellow or gray, and ranges in depth from
3627 coarse, sandy loam to almost loam. Some soils consist of yellow and gray sand grading into coarse sand and grapels at lower depths, the depths of sand and gravel grade from this type in the form of ridges. The Laurel Sandy Loam is found on the south or east side of the area and extends a distance of about one mile from the river proper. There is a small amount of this soil immediately bordering the river on the northwesterly side. This soil is generally subject to overflow from the Laramie River during extreme floods, while owing to its low lying position, the water table is near the surface most of the year. The water table is generally found at a depth of about six feet. In such places as the water surface is less than six feet below the surface, drains would be of great benefit in lowering the water table and in removing any alkali which may tend to reach the surface and concentrate there.

Hay is the principal crop on this soil. It is at present made from native grasses, chiefly among which are wire grass, salt grass, gramma grass and blue stem.

All of these native grasses have a high nutritive value. The average yield of hay is probably in excess of one ton per acre and sometimes produces as much as two tons per acre. This soil is well adapted to barley, wheat, potatoes and oats. Where the water is not too near the surface, alfalfa can be grown with success and

would require little irrigation after the first season. In areas where the water table is near the surface, the alfalfa would probably not do well for more than three years. However, as the value of alfalfa is largely its fertilizing property and as the best values are to be obtained by turning alfalfa under every third or fourth year, this soil put first in alfalfa and then in the higher priced crops such as potatoes, peas and oats would produce wonderful crops.

3628 "In its typical form, the Laramie Sandy Loam consists of a coarse sandy loam varying in depth from three to six feet, and is generally underlaid by sand and gravel. The soil gradually becomes heavier with depth and in some localities grades to a loam which extends to the sub-soil. The Laramie Sandy Loam is generally found north of the river and only a few hundred yards distant therefrom. It extends over the bottom lands and on to the higher areas on the first mesa. Gravel occurs in varying amounts from this soil type, being plentiful on the higher areas. The gravel in this soil consists of quartz, sand stone and lime stone, forming a combination very beneficial to plant growth. The soil is generally sufficiently coarse in texture to permit the rapid percolation of the water, though it retains moisture well. It is extremely unlikely that this character of soil will become alkalied except in such portions as lie too low for proper drainage from the river. This type of soil is believed to be the best adapted for agricultural purposes than any in the region. It is especially adapted to the growth of cereals and alfalfa.

"The Billings clay is the heaviest type of soil found in the area. It occurs in small patches or ridges, principally on the south side of the river and at a distance generally of more than a mile. The soil is derived from blue or black shale and is very heavy. It is compact and almost impervious to water. This soil type contains a considerable percentage of alkali, but occurring as it does on the higher lands, the surface drainage is generally good.

"It is the custom of the farmers along the Laramie River to use an excessive quantity of water in irrigation and to this must be ascribed most of the damage by alkali. With the moderate use of water and a reasonable amount of care, those lands which do not show alkali at this time are in little danger of becoming alkalied. On those areas where alkali does show the more conservative use of water in places, the building of drains or surface ditches will

3629 reclaim the larger portion of the alkali land. The soil towards the river is generally good and on account of the loose texture of most of the soils, the drains would not have to be put close together and would be quite efficient. As the best of the land generally shows alkali which is an indication of its richness, the cost of reclamation is very small as compared with the benefits to be obtained.

The agricultural methods followed in this section differ but little from those areas where agriculture is just beginning to be developed. Heretofore, the attention of the ranchman has been devoted almost entirely to the raising of hay. Little difficulty is experienced in bringing new land under cultivation. It has been the practice, in

bringing new lands under cultivation, to plant them to potatoes or grain.

The virgin soils yield splendid crops, and at this time rotation of crops is practically unknown. With better and more intelligent methods rotation will doubtless be practiced and in this rotation, alfalfa will play an important part. It should be the effort of the farmers who are to cultivate this land to put as much land in alfalfa as practicable during the first few years. This is especially true on the higher lands. On the lower lands, the wild hay crop is very valuable and is becoming more so each year. From those areas where a good hay crop is obtained, especially where the blue stem or wheat grass is found, the meadows should be used for the growing of this kind of hay.

From information obtained from the Wyoming Experiment Station at Laramie, I quote as follows: 'The yield of alfalfa on
3630 the Experiment Farm is on an average, three tons per acre; the average yield of barley is 42 bushels; wheat 35 bushels; field peas 18 bushels. (There are no records however, of the production of peas except during the year 1909); production of oats is 45 bushels; yield of cereals is 60 bushels to the acre, and the average yield of wheat for ten years is 25.5 bushels per acre. On Mill Brook Ranch 107 bushels oats per acre, machine measure, were raised. The average yield of potatoes at Laramie is 94 sacks per acre.'

From this letter and other information gathered, the average crops of this region I judge to be about as follows: Oats, 40 to 50 bushels per acre; Barley, 30 bushels per acre; Peas, 30 bushels per acre; Alfalfa, two and one-half tons; Timothy and Wild grasses, one to two tons.

The present yield of potatoes seems to be rather low. By using alfalfa as a fertilizing agent preceding the planting of potatoes, I do not doubt that 200 sacks per acre will be produced.

From the examination of the possibilities of this section, one is impressed with the fact that there is a very extensive and excellent range country surrounding it on all sides. The Laramie Plains furnish pasture lands for the winter months, while the higher mountain areas furnish pasture during the summer. A farmer having a home place along the Laramie River of perhaps 160 acres, can range his herds and flocks on cheap land belonging to himself and on the public domain. If he is fortunate enough to control a section of land on which there is a spring or stock water, he will have surrounding him a very considerable area for grazing, which
3631 on account of the want of water elsewhere, will not be available to anyone not similarly situated. On this land his stock is grown and matured. During severe winters, it can be fed on the farm, and when matured, it can be brought to the home farm, fattened and disposed of. Barley, oats, peas and alfalfa are fully as efficient and very much less expensive than corn. Stock so fattened commands a price equally as high as corn fed stuff. Likewise, hogs can be grown and fattened in this region with little expense. Cholera is practically unknown and the pea fed hog is much sought after by the local butchers and by the packers.

The value of farms in this region appears to be along the line suggested. It is a well known fact that horses raised in this locality are of excellent quality, and I anticipate that this district and Wyoming in general will, in the very near future, become one of the principal horse producing states in the Union.

The value of land at this time is hard to determine. The prospects of the future are so bright, and yet the country is at present in such an undeveloped condition, that one is at a loss to adjust the values which have been obtained until very recently with those which will undoubtedly be obtained in the near future.

Similar land in Colorado, but lying perhaps 500 feet higher, is worth with a good water right from $50.00 to $100.00 per acre. Generally speaking, the Colorado District has not as good railroad facilities, nor has it generally water rights equal to those on the farms which we are considering.

First, the annual cost of maintenance is considerably greater, and reservoirs are generally required; drainage is often necessary, and care must be exercised to prevent the accumulation of alkali. In this district around Laramie, I am creditably informed that water rights are worth about Thirty Dollars per acre; that land
3652 without water but with a possibility of obtaining water is worth from Twenty to Thirty Dollars per acre. It is a well known fact that a combination of land and water is more valuable than either of those essentials separately. This added value, generally called the 'Value of Assemblage' is considerable. I judge, therefore, that the lands in question have a value off from Thirty-five to Seventy-five Dollars per acre with a water right. The grazing lands are valuable for the reasons stated in other parts of this report, and depending upon their location and quality vary from Three Dollars to Ten Dollars per acre. In the case of Ten Dollar land, it must be so situated that stock water can be obtained. The three dollar land would be that which was mountainous and with a poor growth of grass, and possibly without stock water.

The possession of both irrigable land and pasture land should give an added value to both. That portion of the Company's land which lies near the town of Laramie, is of excellent quality and with water would be the most valuable which the Company owns. Water can be obtained for this land at about Thirty Dollars per acre. Although the roads in this district are unusually good for the use of automobiles, and any of the land is desirable for residence purposes, nevertheless, the cost of the transportation of produce to the railroad would be considerable for the more distant sections, and it is probable for this reason that the lands near Laramie are the most valuable."

* * * * * * *

"In considering the water rights on the several tracts, a preliminary statement is necessary for an understanding of the conditions.

The land, considering the water rights, might be divided into three heads:

First, Those lands which now have a decree. These decrees are shown by the records in the office of the State Engineer of Wyoming,

and in the office of the Board of Irrigation. When these decrees were granted, the grantors of the Company made proof on a considerably larger area than is called for in the decrees. The Company has instituted suit against the state officials to compel them to grant further decrees on the old rights. Those lands which are involved in this contest constitute the second class. The third class are those lands for which no decree has been granted, and on which the Company does not claim water under the old ditches, but claims water under its more recent appropriations.

The conditions can best be studied by taking up the several ditches and their decrees, and showing the area decreed, the area in contest, and the area for which application has been made.

The most important, as it involves the greatest area is the land covered by the King Ditch and the King Ditch enlargement and Extension. By the decrees, the King Ditch covers 2106.7 acres of land. This area is shown in color on the attached map. The contested land under this canal is as follows:

All that portion of the north half of Section 2, Township 13 North, Range 76 West, not covered by the decree, amounting to about 200 acres. The King Ditch has a very considerable fall, and it is possible to irrigate land, not only lying to the north, but also lying to the south of the ditch. The present decree covers simply that portion which lies to the north of the ditch.

3634 In Section 1 of the same township, the same condition exists, and the amount of land which can be covered is about 160 acres.

In Township 13 north, Range 75 West, all of the land belonging to the Company can be covered, amounting to 80 acres.

In Section 5, 200 acres is in contest.

In Township 14 North, Range 75 West, Section 32, 160 acres is in contest.

In Section 33 all except a small portion in the southwest corner is in contest, amounting to about 320 acres.

In Section 28 all of the land not included in the Caldwell appropriation is in contest. This amounts to 200 acres.

All of Section 27 is contested. In this section, however, a considerable portion can be irrigated from Caldwell Lake, and whether the contest is successful or not, at least 160 acres can be irrigated from the Lake.

In Section 23, lying above the Haley and Hoge Ditch there is contested about 400 acres.

Section 25 is under the King Extension, and permit is sought for its irrigation on account of the extension.

In Township 14 North, Range 74 West, the King Extension covers nearly all of the land belonging to the Company not otherwise covered, amounting to about 800 acres, it being the intention to extend the King Ditch to cover the lands in Sections 17, 9 and 8. Of the Sections touched by the King Extension, there is above the canal some 3,300 acres, for which there is no water.

Caldwell and Gardner Ditch: The Caldwell and Gardner Ditch has a decree for 1,523 acres. It can also be made to cover lands in

Sections 27 and 28, Township 14 North, Range 75 West. As
3635 previously stated these lands are in contest.

The Riverside Number One Ditch has rights for 1,470 acres. It also covers all the lands in Section 29, Township 14 North, Range 75 West, in amount about 400 acres. This land is also in contest. The canal could be made to cover the land in Section 21 as well, but as this section is also covered by the Riverside Number Two Ditch, for the purpose of this discussion it is assigned to that canal.

Riverside Number Two Ditch has two decrees, one for 2514 acres and the other for 1,024 acres. It is proposed to change the grade at the upper end of the canal, which can easily be done, keeping it on higher ground. This will make it possible to irrigate all the lands of the Company in Sections 27, 26 and 23, Township 14 North, Range 76 West, about 285 acres. It can also be made to cover the balance of Sections 19, 21, 15 and 11. The contest referred to covers these lands, in amount to about 1,150 acres.

The Haley and Hoge decrees call for 1,571 and 637 acres. This ditch also covers a considerable part of Sections 22 and 23, Township 14 North, Range 75 West, which have no decrees, and which amounts to nearly 500 acres.

In reference to the contested lands, I would say that the evidence so far taken in the suit indicates that the Company has a valid right to nearly all of the land in contest. Furthermore, the amount of water available to the canals, and the amount of water in the river, justifies one assuming that in some manner these lands can
3636 and will receive water. By means of rotation even present decrees would furnish sufficient water, though under the laws of Wyoming these decrees could not be used on the additional land except after a permit was obtained. With the certainty of an abundant water supply, these lands could in any case be served by filing an enlargement and extension on the several ditches. As before stated, this has already been done, so that regardless of the outcome of the suit, it appears certain that those lands will in time have a decree."

* * * * * * *

"My conclusions are, that the Company has acquired a valuable property; that the water rights are ample, and probably as free from complications as can be found on a tract of similar size, and which has the old valuable decrees dating from Territorial Days. Later decrees, covering an equal body of land, would be less complicated, but would be very much less valuable. It is the value of the old decrees that justifies the Company in seeking to cover as much as possible of their land by them.

My conclusion is further that the land should be subdivided into tracts of 160 acres or more, and that the purchaser should, so far as his means permit, acquire pasture land for summer use and for growing his stock, which will later be fed and matured on the farm; that with such a combination, the property would be more valuable than if either were owned separately; that the presence of a trans-continental railroad so close to the land, with the certainty of

other roads in the near future, justifies one in predicting that the land will increase rapidly in value.

I would recommend that as far as possible the water rights be consolidated, and that in the sale of land an effort be made to give each purchaser a water right of practically equal value. This
3637 effort of having the values of the water rights equal might also be extended, and the farms themselves made as nearly equal in value as practicable.

I would further recommend that the sales, at first, be limited to actual settlers, and so far as possible the speculative element be excluded.

Before the land passes into the hands of the farmers, I would recommend that a study be made of the seepage and drainage conditions; that a comprehensive system of drainage be laid down, and that revisions be made for necessary rights of way for drainage canals, to the end that should drainage become necessary and advisable, the rights of way will have been provided, and the settlers will have an idea how to proceed."

I gave general instructions to the party making the plane table survey of the Laramie Plains region, and I visited them a number of times and examined their maps during the progress of the work, and found that they represented the actual conditions. As ascertained from the plane table survey the amount of land actually irrigated was less than 50% of the amount lying under the old ditches, and there is another large acreage lying under the newly
3638 constructed ditches of the Lake Hattie system. In addition to the land lying under the ditches already constructed, the greater part of all of the land upon the Laramie Plains could be brought under ditch. In view of the great many depressed areas and alkali spots scattered over the area I would say that about 60 per cent of all of the land under the present ditches could profitably be irrigated.

3640 While there is opportunity for the extension by individual effort of ditches already constructed on the Laramie Plains, there is little opportunity left for the construction of new ditches by individual effort, and the main development to which that area must look must be the Lake James and Lake Hattie systems principally, the construction of which is not a matter of individual effort but must come through a large organization, while on the other hand the utilization of water furnished by these systems is always a matter of individual effort, which the constructing companies can influence only by means of presenting attractive prices. I do not believe the cause for the postponement of the utilization of the Lake James and Lake Hattie systems however, is that the water is held at too high a price, but that it is not profitable to farm in that region.

3641 Exclusive of the water surfaces of the Laramie Plains, I estimate that there are wet areas aggregating about 10,000 acres which lead to excessive loss through evaporation. These areas are composed of a strip perhaps a mile wide and several miles long, lying between the Pioneer Canal and the rise of the hill to the north

near the northeast corner of Township 14, Range 76, and
3642 a considerable amount of wet land in and around the Little Laramie River. This latter includes a considerable area near Two Rivers and another area in the vicinity of the Bath ranch which was so wet that it was almost impossible to get through with a rig. A large part of this land was not cut over at all. There are
3643 also wet alkali tracts around all of the lakes. In my consideration of these wet areas I have endeavored to exclude all land that is irrigated and to include only those lands which have become so wet without intention on the part of the owner. I made no list of these lands because the area of wet and useless land was vastly in excess of the estimate I have made, and I thought it was unnecessary. We did not have a plane table survey made of these wet areas because we did not have the time or the money.

3644 From maps prepared by other people I have made up a list of the water surfaces upon the Laramie Plains consisting of lakes and ponds from all of which there is evaporation which I considered as waste water. These water areas aggregate 6,379.19 acres, of which 3,000 acres lie in the Cooper lakes and 146.98 acres in Creighton Lakes, which are on the south side of the Laramie River and about three miles distant, being supplied with water principally from Antelope Creek and from Sand Creek, the water of which is carried into Antelope Creek through ditches which cover land above the lakes. A small dam has been constructed at Creighton Lakes and some work performed looking towards the future use of those creeks for irrigation purposes. There has been irrigation from Sand Creek and Antelope Creek for many years but I do not think it has progressed during the past five years. Cooper Lake
3649 has an area of nearly 3,200 acres. It lies west of the Laramie River about four miles, in the northerly part of the valley. I do not think that Cooper Lake has ever been a tributary to the Laramie River and I referred to it merely because it is a convenient source of supply that might be utilized for the Laramie Plains
3650 area. Its water supply is Dutton and Cooper creeks, from which there are a number of small ditches taking water. I do not know whether the amount of land irrigated from those two creeks has increased materially within the last few years.

3651 I have not included Lake Ione in my list because it has been turned through a cut into the river and the land is now being farmed. I would say that the area of Lake Ione would be about the same as the area of Creighton Lakes. The other large area of water surface is Hutton Lake, containing 392 acres, lying just south of Creighton Lakes and generally considered as a unit with Creighton Lakes. Hutton Lake is a part of the system being developed for irrigation by the Denver and Laramie Realty Company, whereby it is contemplated to irrigate a rather large area of land not heretofore irrigated.

In my discussion of stream flow measurements my use of the term "mean" or "normal" flow relates to the run-off in an average year. When the flow in any year is above this average or normal, the surplus above the average flow is conserved and held over for use in

later years when the flow is below the normal, so that the water available over a period of years is theoretically the same as
3652 the normal or average flow of the stream. Where reservoir facilities are not sufficient this theoretical available amount is not the same as the practical available supply, but on the Laramie Plains the normal supply represents the practical available supply on account of the situation of the Wheatland Reservoir at the lower end of the valley, being a channel reservoir which can hold and conserve all the water passing down the river. In this particular the Laramie Plains is in a fortunate situation.

3653 WILLIAM ILIFF, a witness in behalf of defendants.

Direct examination by Mr. Delph E. Carpenter:

Reside Denver, Colo. General security business. Engaged that and similar business for period of years in Colorado. Identified with the Laramie-Poudre Reservoirs and Irrigation Company since 1908 or 1909. Do not recall exact year.

As director came in contact more or less with finances, but not very much until latter part 1911 or fore part 1912. At that time when Farsons Sons & Company notified The Laramie-Poudre Reservoirs and Irrigation Company that they would be unable to go ahead with their contract I became active in finances of company. Farsons gave as reason for their inability to sell bonds that there was a general attack upon the enterprise; that it reached their cus-
3654 tomers and that they were unable to sell bonds. I am not familiar with what attack they referred to except in very general terms, except that there was whole lot of literature scattered throughout east emanating as I am told from Wyoming principally, which found its way to their customers and which prevented a continuance of their selling bonds. That was literature advertisting fact of present pending suit, or threatening of bringing suit, as I understand.

Became active in affairs of company about time Farsons notified company of their inability to sell on this account. Became active about February 1, 1912 and for following six or seven months, probably a little longer, I gave practically my entire time in an endeavor to re-finance company so that project would be completed. Devoted my efforts principally in New York, some in Philadelphia, some in Baltimore and in Chicago. Was personally in those cities during that period.

Was unable to re-arrange financial affairs of The Laramie-Poudre Reservoirs and Irrigation Company so that they could complete this enterprise. Was unable to re-finance project. Two obstacles prevented:—first, was general depression of security market especially in regard to irrigation bonds which however, was overcome by being able to present very attractive proposition, but when attorneys got hold of legal end of it and found Colorado-Wyoming suit
3655 pending, they advised their clients not to go into law suit and one proposition after another failed on that account. Was not able to overcome first obstacle, general depression of securities,

with all of the financiers with whom I was dealing. Two or three would consider proposition on financial basis subject to legality. When legality was investigated Wyoming-Colorado suit was obstacle. Understand that has continued to be obstacle to present time. Have not actively attempted to do anything since 1912.

At time of formation of district securities were sold to Farsons, Son and Co., through instrumentality probably of Mr. Camfield and Mr. Shields. Mr. Camfield assumed active duties in connection with financial end of The Laramie-Poudre Reservoirs and Irrigation Company's business, that is of procuring sale of bonds, etc., prior as well as subsequent to 1912. My assistance was only during 1912. Whole idea was to save ourselves from loss if possible, or as much loss as possible.

3656 Cross-examination by Mr. N. E. Corthell:

I was connected with the Laramie-Poudre Reservoirs and Irrigation Company as a director practically from its organization. At first I was interested as a bondholder, but at a later date I became interested as a heavy stockholder. In 1912 I became owner of 360 acres of land in the Irrigation District. I took up the matter
3657 of endeavoring to finance the Company merely in order to save my own heavy investment, and I received no salary or compensation for my work, and paid my own expenses. Farson & Son reported at the end of 1911 that they could not sell any more bonds on account of the reports relative to this suit by Wyoming which had been sent broadcast. I went to Baltimore with
3658 one of their salesmen, and a bank there which had purchased some bonds refused to take any more on account of the threatened suit. As to whether the suit had then been started I do not know. We were able to overcome the general sentiment
3659 against the purchase of irrigation bonds, had not these other matters intervened. The condition of the irrigation bond market has been very poor since the first of 1912, and I have never had anything to do with any issue excepting the one of the
3660 Greeley-Poudre District, so do not know whether other irrigation bonds have been sold during that period or not. From general report I know that there have been many cases of the organization of irrigation districts in unsettled territory which have failed.

3660 Redirect examination by Mr. Delph E. Carpenter:

We had already come to an agreement as to financial terms, and in two instances, I considered financial end of it actually closed and so telegraphed those interested in Colorado, only to have it fail after principals were advised not to go into enterprise on account of suits that were pending or threatened, I do not know which, threat-
3661 ened trouble with Wyoming, that is way it was stated. I was able to make financial terms by making securities attractive by bonuses of various kinds. No matter what position of other systems might have been, this would have been completed but for blight

of Wyoming suit. I never know what financiers will do until they get their money down, I learned that from experience, but I was so sanguine, so sure of it, that I proceeded on that assumption.

Over $2,000,000 of bonds had been sold by Farson, Sons & Co., prior to their inability to further sell bonds on account of this suit, as I understand.

As I recall, prior to 1912, one Clarence T. Johnston, then Wyoming State Engineer, was persistent to offering to the press various statements and letters, in which he published broadcast to world that the Greeley-Poudre system must be doomed to failure and that their water supply was of no avail in so far as Laramie river was concerned, and particularly in letters of September 15, 1909, and March 7, 1910, and published through Associated Press in Denver Republican on September 18, 1909, and August 4, 1910. My recol-
3662 lection is that such letters were in the office of The Laramie-Poudre Reservoirs and Irrigation Company but from my own positive knowledge could not say. I was not in such relation with company at any time as to enable me to look through the files.

It was matter of common knowledge, while I was in New York and Chicago, that letters and dispatches of this character had been circulated freely in financial centers, even while Farson, Sons and Co., were engaged in selling bonds disposed of by them.

Recross-examination by Mr. N. E. Corthell:

It was matter of common knowledge that data of various kinds was being circulated through east attacking Greeley-Poudre enterprise in various ways. I simply know what various members of companies have told me, Mr. Camfield and Mr. Shields stated that such was attack made on enterprise, and Farson, Sons and Co., gave it as a reason why they were unable to continue their contract in taking up the bonds. It was on account of their inability to sell securities due to wide circulation of attacks of different kinds on district. I saw circulars that were handed me to look at. I kept none and cannot say except from memory, that is general impression I have of whole matter.

3663 Redirect examination by Mr. Fred Farrar:

Immediately after commencement of construction on Greeley-Poudre enterprise, there was a great deal of activity. There were a number of towns that were organized in the district and there was a great deal of land taken up. Considerable land was fenced, houses were constructed, and, as time went on, I noted increased activity there and an increased number of people who had come into district both in towns and throughout district. These were Pierce, Nunn, Briggsdale, Camfield and Hungerford. A great many persons acquired land in the district. Towns of Nunn and Pierce are both on main line of Union Pacific Railroad between Denver and Cheyenne.

Hungerford, Camfield and Briggsdale are to east in main body of district and on branch of Union Pacific Railroad constructed by the

Railroad Company into the district anticipating revenues from district when system was completed.

3664 These towns became very thrifty. For new towns, springing up as they did, they were constructed quite substantially with brick buildings, a number of them. Was interested in enterprise and generally noticed character of improvements. Banks were established in both Pierce and Nunn and think at Camfield. There were usual and customary mercantile establishments in those towns. They were normal western towns. Development was very satisfactory from my point of view as a security holder in the enterprise. These towns were formed through individuals and associations. I do not think The Laramie-Poudre Reservoirs and Irrigation Company had anything to do with any of them, certainly not to my knowledge.

Safety of investment in the Greeley-Poudre enterprise and prosperity of the people who have invested and reside in the towns, depends upon completion of district and watering of lands. These towns did not exist, to my knowledge, before enterprise was

3665 projected. I know they grew from practically nothing to more substantial little towns after enterprise was projected. In inception of this enterprise I only made investment in bonds and it was only later that I became very heavily interested and visited and took an interest to go over district personally. The general development was made after the enterprise was started.

Examination by Mr. Delph E. Carpenter:

An item appearing on page 7 of the Denver Republican of Saturday, September 18, 1909, reads as follows:

"Wyoming Warns Ditchmen of Trouble Ahead.

Diverters of water from Big Laramie will be prosecuted. Need at home for all supply that can be conserved. Says diversion to Colorado will ruin districts of Albany and North Laramie."

"CHEYENNE, WYO., Sept. 17.—(Special.)

The following letter has been sent by State Engineer Johnston to every member of a company which is planning to take water from the Big Laramie river for use on land outside the state:

"Realizing fully the complications which arise after construction has been undertaken and money invested in an irrigation project where the water supply is inadequate, we are taking this op-

3666 portunity to notify you that the water of the Big Laramie river and its tributaries is fully appropriated in the state of Wyoming.

Any further diversion of the waters of the Laramie river for use in irrigation outside of the drainage area of the stream would injure Wyoming appropriators. The state of Wyoming, with the proper government authorities, has maintained measurements on

the Laramie river for a long term of years. There are many years when the flow of the stream has been wholly inadequate for the Wyoming lands under ditch, except through the utilization of large volumes of stored water. Reservoirs have already been constructed which store 130,000 acre feet of water from the Laramie river in Wyoming. Reservoirs are under construction which will store 75,000 acre feet in addition. When these reservoirs are completed they will have sufficient capacity to store all the waters of the Laramie river during the season of minimum flow, and to reclaim all of the lands under these reservoir systems it will be necessary to store water and hold it from one year to another, if we are to develop stable agricultural communities.

You are doubtless familiar with conditions on Sand Creek, a tributary of the Laramie river, which has its source in Colorado. Several years ago an attempt was made to divert the waters of Sand Creek in Colorado without regard to the rights of prior appropriators in Wyoming. Wyoming water users immediately secured an injunction in the United States courts.

A diversion from the Laramie river, such as contemplated, would ruin Albany county and northern Laramie county as agri-
3667 cultural districts. The state of Wyoming will therefore encourage every move to protect the water users and to protect the interest of the state along this stream. Should a diversion, as is contemplated, be attempted, resort must be had to the United States Courts for protection."

That is one of the articles I had in mind. The following appears in the Denver Republican of date Thursday, August 4, 1910, on the front page which with bold headlines reads as follows:

"*Wyoming Will Start Water Suit.*

Would Prevent Completion of Laramie-Poudre Project.

Attorney General Is Now Preparing Case.

Colorado Officials Confident That Completion of System Can't Be Stopped.

The Attorney General of Wyoming is preparing to bring a suit in the supreme court of the United States against the state of Colorado in an effort to prevent the carrying out of the proposed Laramie-Poudre Irrigation project. Although the Colorado officials are confident that the diverting of the waters of the Laramie river for this big irrigation project cannot be prevented by the Wyoming men, who claim that their rights are being injured, a suit similar in some respects to the Kansas-Colorado case will be filed shortly and it is understood the Supreme Court will be called upon to again
3668 pass upon the rights of Colorado to use the waters in her streams for the purpose of irrigation.

It has been expected for some time that there would be an effort on the part of Wyoming men to prevent the big project, which will reclaim many acres of northern Colorado land from being carried out, but only recently has it been learned that the attorney general of Wyoming is preparing to bring a suit against Colorado in the United States Court.

Do Not Want Waters of the River Diverted.

Wyoming takes the position that the waters of the Laramie are all used in Wyoming and in the valley of the Laramie in Colorado and that the possibility of further development of the irrigated area from that stream is very remote and if the lands along the Laramie in Colorado were irrigated to the fullest extent no harm would be done to Wyoming users because the return waters would all go back to the main stream.

The Laramie-Poudre project they claim diverts the water of the river from its own watershed and they will be lost so far as the Wyoming water users are concerned. If no water is diverted from the Laramie watershed they believe that it might be possible to reclaim some of the lands on the Laramie Plains, but this is held hopeless if any of the water is diverted according to the irrigation plans of Colorado men.

"This office has kept a record of the flow of the Laramie river near the Colorado-Wyoming line for many years" says Clarence T. Johnston, state engineer of Wyoming, in speaking of the proposed suit. "For ten years the average flow was 117,000 acre feet of water per year. We have one reservoir on the Laramie which has an earlier right than the proposed Poudre-Laramie diversion, for 120,000 acre feet of water. In addition to this we have about
3669 300,000 acres of land that has earlier rights, and all of this is irrigated from the direct flow of the river.

"The state also holds that an interstate adjudication by the United States Court will settle the question involved in accordance with some principle that can be carried into effect in both states. We believe that beneficial use will be the basis of this decision. We believe that the court must decide whether water rights belong to persons who can change them from one tract to another and from one watershed to another or whether the water rights belong to the lands reclaimed.

Colorado state officials believe that the Colorado-Kansas case has settled the question of the right of a state to use its water as it sees fit. The Laramie-Poudre Company has purchased many water rights and have gone to great expense to plan the reclamation of a large area in northern Colorado. It is believed that there is little danger that the supreme court of the United States will interfere and prevent the carrying out of the project.

The Wyoming men base their contention that the water rights belong not to the individuals but to the land that has been reclaimed, as held in the recent Arizona case in which the United States inter-

vened in the adjudication of rights to use water from Salt River. The case was decided on March 1st of this year and is entitled "Patrick T. Hurley, The United States, Intervenor, vs. 488 other users.'"

That is one of the various Associated Press articles I remember of seeing. That and similar articles did not have a very beneficial effect on bond market of irrigation securities. Those articles
3670 have evidence of appearing from official Wyoming sources. Denver Republican was an old well established daily in Denver carrying very heavy Associated Press business. It was one of best established daily newspapers west of Missouri River. It is a fact that Farson, Sons & Co. referred to article of August 4, 1910, which I just mentioned, among other references in stating fact that attacks on bonds were such that Wyoming suit prevented further sale of bonds.

JOHN E. FIELD.

Cross-examination by Mr. John D. Clark:

3671 The Weatland Reservoir differs from most of the reservoirs on the Poudre River in being a channel reservoir. The Halligan Reservoir, a reservoir on Sheep Creek, and Chambers Lake are the only channel reservoirs on the Poudre River, but there are three large channel reservoirs now proposed as part of the Greeley-Poudre system. The Wheatland Reservoir is the only channel reservoir upon the Laramie River in Wyoming and its location gives it a very considerable advantage. It acts as an equalizer of the whole stream during the season and from year to year, as it is never necessary to permit water to waste, and by the conserving of water when not needed upon the Wheatland tract relieves the demand on the river and makes it possible for higher ditches to get water when otherwise they might not be able to do so if there was a shortage in the water supply, a situation which does not now exist. Since its completion the Wheatland Reservoir has very largely increased the effectiveness of the whole river and its capacity is so large that it can practically conserve the flow of the river. There was one year when water passed over the spillway of the reservoir, but I think the history of the reservoir is that no attempt has been made to hold all of the water because it was not needed. Under present conditions with James Lake and Lake Hattie constructed and the Greeley-Poudre Tunnel opened, the large overflow of 1909 might all be taken care of or at least very considerably reduced, and there are other reservoir sites upon the Laramie Plains which might be utilized if necessary. It is my opinion, however, that the irrigation enterprises which have been more recently constructed are not
3674 justified, and a further development would be even less justified. The capacity of the Wheatland Reservoir could also be increased by digging a channel so as to reduce the area of the dead body of water, and I believe that this work has been largely performed already. It would also be possible to draw off water from the Wheatland Number Two Reservoir into the Wheatland Number

One Reservoir in order to have the Number Two reservoir available for subsequent floods.

In 1912, 162,370 acre feet passed in and through the Wheatland Reservoir and there were 47,000 acre feet remaining at the end of the year. A total of 80,700 acre feet was stored in Lake Hattie in that year and 22,000 acre feet were stored in Lake James. As-
3675 suming that the Wheatland Reservoir No. 2 was filled to its capacity in 1912, the 80,000 acre feet stored in Lake Hattie and the 22,000 acre feet stored in Lake James would have gone to waste in 1912 if these reservoirs had not been constructed, the water passing through the Wheatland Reservoir over the Spillway or through the valves and down the Laramie River. Neither Lake Hattie nor Lake James was in existence in the years from 1903 to 1908, and there would be no opportunity to store any of this water in these years, and if that amount of water had flowed in the river during these years it would have passed down the river, excepting such as was used at Wheatland. The six years 1903 to 1909 inclusive on the Poudre River average 109 per cent of the average flow in 30 years, and I would say that there would be the same relative flow over the same period in the Laramie River. I would say,
3676 therefore, that if in the years 1903 to 1909 inclusive, no water did pass the Wheatland Reservoir, it follows that the flow of Laramie River in 1912 exceeded the flow in the years named by at least 100,000 acre feet.

In Exhibit 127 I did not use the records of the flow of the Laramie River at Woods Landing for the years 1889 to 1893 inclusive because I considered that some of them were not entirely reliable, and I did not have the original data with which to check them up. In some of my calculations, and in Exhibit 128, I included the published records for these years and found that they did not greatly change the results.

3677 Most common method of measurement to ascertain flow of rivers is by use of an instrument, called a current meter, to determine velocity of the stream. The cross section of the stream is obtained by measuring the depth of water at regular intervals of one, two, or even five feet, and these depths, together with the widths of the different sections, added, give the total cross section of the stream.

The current meter is used to determine the velocity of water in each of the sections, and the discharge is computed by multiplying the cross area of that section by the velocity which is obtained for that particular section.

There are a number of methods for handling the meter. The average velocity of the section is what is desired and many measurements have been made to ascertain what methods are the better to use.

What is known as the integration method is most common. It is performed by allowing the meter to sink to the bed of the stream and then slowly raising it to the surface and again allowing it to sink to the bottom of the river. Different observers use slightly different methods in getting integration in this manner. The result

obtained by raising and lowering the meter in this manner is considered the average velocity of the section.

Another method which is sometimes used, where, for any reason the integration method cannot be used, is to take the surface velocity. This method is perhaps the least desirable and less used method, and it requires judgment to apply the proper coefficient, the surface of the water running at a considerably higher velocity than the average velocity.

Another method, known as the six-tenths method, is obtained by placing the meter at a depth of six tenths of the total depth of the section and measurements have shown that generally by holding the meter at that six-tenths point, the velocity obtained is the average velocity of the section.

3678 Where the current meter is not used, a weir may be placed across the river and we have formulae from which we can calculate the flow. These formulae have been determined by actual measurements. On a weir properly constructed and the observations carefully made, this will give closer results than the meter methods, but unless the conditions are almost perfect, the meter method is equally reliable.

Meters have been in use for twenty years to my knowledge. They have been considerably improved during that period. Greatest improvement was during 1897 or 1898. About that time we used a recording apparatus which was a clock arrangement, which recorded the revolutions.

Since that time, the revolutions are counted by the observer by the use of a small telephone which transmits to his ear the click when the circuit is closed as the meter revolves. That improvement, I think, was a considerable advance in the use of the meter.

The operator times himself with a stop watch. He starts his stop watch when he hears the click, which is the beginning of a revolution, and then counts the clicks as long as he thinks it is necessary and the watch is then stopped and the time read and the number of revolutions recorded.

This telephone apparatus is so arranged that in some cases every revolution is heard and in others every fourth of fifth revolution only is heard. The reason for using the apparatus which records only the fourth or fifth revolution is that often the velocity of the current is so great that it would be impracticable to count as fast as the meter revolves.

3679 The object of these two measurements which I have described is to ascertain the cross section area and the velocity of the flow. From these the flow in cubic feet per second is ascertained by a mathematical computation. That is the discharge measurement. From this discharge measurement, by mathematical computation, the discharge is computed over any period that is desired. Observations are made in the stream at different heights and the water discharge at different heights is recorded. These discharges are plotted and based on the quantity of discharge and the gauge height. A curve is then constructed which gives the intermediate points. A number of

observations, even at the same point, are desirable, so that errors from observation may be eliminated as far as practicable.

Discharge for the year is generally computed by constructing such a curve and computing a table for the discharge at each one-tenth of a foot on rise or fall of the river. The daily gauge heights are observed or recorded on an automatic register and from the gauge heights so recorded, the daily discharge is computed. The aggregate daily discharge gives the total yearly flow if observations were kept up for the entire year.

It is necessary to make these current meter measurements at different stages of the river in order to secure the table from which to estimate the velocity at different heights. The velocity of flow varies considerably with the rise and fall of the river. Velocity is not in direct proportion to the depth and varies in different streams, so that actual observations are necessary to construct proper rating tables.

3680 Accuracy of discharge curve depends largely upon number of measurements which have been made to fix the table. Table of velocity arranges itself in a curve. Where the channel is shifting and bed of river is not permanent, where channel is choked above or below stations, and where there are boulders or other impediments in stream, such as bridge piers, etc. More observations are necessary. Where channel is permanent and what we call a good station, where flow of water in different sections is approximately parallel and grade of river above and below the station is fairly uniform, a single observation gives very good results, and a good observer with one observation can produce reliable results.

Possibility of error would be greater where discharge and velocities are greater. It is more difficult to make observations when river is high and velocity is great. For that reason it might be that an observation at higher stages would not be as good as it was at lower stages, although there are conditions of river where observations at lower stages are questionable. It is also true that in cases of extremely high flows, computation is derived from extending the velocity curve and not from actual measurement, so there is possibility of error in that particular. Where you have to extend your curve, errors are liable to be made. Extension of curve is matter of judgment. It is always desirable to have actual maximum discharge made from an observation, so that higher point on curve is not left to judgment of hydrographer. If hydrographer is forced to make observations at a point where the channel is filled with boulders, his records, of course, while the best that he can get, are not as reliable as with a good channel. A single measurement at a perfect cross-section or station would be sufficient for determining flow at a given height, but not for all heights. You must have intermediate points and the more the better.

3682 WILLIAM S. ILIFF, recalled.

Direct examination by Mr. Delph E. Carpenter:

Miss T. H. Marso is my private secretary. She is secretary at present time of The Laramie-Poudre Reservoirs and Irrigation Company. Records of Secretary of that company are kept by my private secretary. Since testifying this morning Miss Marso and I have searched through letter files of the company for letters referring to letters and articles emanating from Wyoming authorities or persons reflecting on bonds of Greeley-Poudre Irrigation District. We found letters. They are from Farson, Sons and Co. of September 23, 1909, and March 31, 1910, and signed by John Farson, Junior. Letter of March 31 had enclosure, a letter dated at Laramie, Wyoming, March 25, 1910, and directed to Editor of United States Investor and signed by George A. Campbell, Secretary of Laramie River Association. United States Investor is financial paper published in
3683 New York City. Letter of September 23, 1909, reads as follows:

"CHICAGO, Sept. Twenty-third.
Nineteen Hundred Nine.

Mr. S. H. Shields, Secretary Empire Construction Company, Denver, Colorado.

DEAR SIR: We are this morning in receipt of a letter from Mr. F. H. Bowen, General Superintendent of the Lake Hattie Reservoir & Irrigation Company, Laramie, Wyoming, together with a clipping from "The Laramie Republican" dated September 18th, intimating that if any effort was made to take water from the Laramie river for account of the Greeley-Poudre District, it would be bitterly contested in the courts. This clipping includes a letter from Mr. Johnston, State Engineer of Wyoming, which is very forcible in its tone.

If you have not seen this letter we suggest you most carefully look it over without delay. We have made no answer to the letter.

With our best respects, we are,

Yours truly,

(Signed) FARSON, SONS & CO."

J. F.—F.
C. N. Y.—D.

This letter is addressed to S. H. Shields as Secretary Empire Construction Company which was company of Messrs. Camfield and Shields, formed for purpose of constructing irrigation projects and especially North Sterling and Riverside Projects, just prior
3684 to Laramie-Poudre Project. Substitution of that company for Laramie-Poudre Reservoirs and Irrigation Company was evidently an inadvertence. Letter of March 31, 1910 and enclosure accompanying same, omitting notation at bottom of original letter concerning other matter, reads as follows:

"CHICAGO, March Thirty-first,
Nineteen Hundred Ten.

Personal.

Mr. D. A. Camfield, Century Building, Denver, Colorado.

MY DEAR MR. CAMFIELD: Recently the United States Investor, a New York publication, had a very good article recommending the Weld County, which article evidently fell into the hands of a fellow named Campbell, with result that he has written the U. S. Investor as per copy herewith.

Will take this matter up and straighten it out as soon as I get to New York. Just wanted you to see this article.

With my best respects, I am,

Yours truly,

(Signed) JOHN FARSON, JR.

J. F., Jr.—F.
C. N. Y.

Encl.

Copy.

Weld County, Colo., Irrigation Bonds.

LARAMIE, WYO., March 25, 1910.

EDITOR UNITED STATES INVESTOR: I have, before me, a clipping from a paper which purports to be a reply given by you to
3685 an inquiry concerning the reliability of the irrigation bonds of the Greeley-Poudre Irrigation District, In Weld County, Colorado. You are quoted as saying, in substance, that these bonds are a safe investment.

I feel sure that you have not full information concerning this matter, and that your opinion is based upon the reports and statements made by those interested in selling the bonds.

The promoters of the district propose to divert the water of the Laramie river to accomplish the irrigation of lands in the district.

The fact is that only a small part of the water of the Laramie river has ever been used in irrigation of lands in Colorado, and the chief flow has been appropriated and used in Wyoming. There are something like 125,000 acres in Wyoming now irrigated by the Laramie river, which flows for many miles through this state. The appropriators of this water have banded together and raised a large sum of money for use in law suits, which are about to be instituted to prevent the proposed diversion of the waters of the Laramie river. The decision of the case between Kansas and Colorado by the Supreme Court of the United States is entirely in favor of Wyoming appropriators, as you may determine by reading the closing paragraph of the decision. It is certainly based on justice to protect the rights of the irrigators of 125,000 acres of land in Wyoming against the diversion of water to another watershed for use upon an entirely

new area. In other words, it is not justice to destroy the property of one locality to increase the value of lands in another, where no question of eminent domain can enter.

I have full detailed information on each point in the whole
3686 plan of the Greeley-Poudre Irrigation District, and can assure you that the promoters are about to run against trouble.

I deem it only fair to those thinking of investing in the bonds in question, that publicity of the impending suits be given.

One of the bills of complaint prepared by the best legal authorities of this region, now lies on the desk before me ready to be filed in court.

Yours truly, GEO. A. CAMPBELL,
Sec'y Laramie River Ass'n."

Mr. Camfield was president of The Laramie-Poudre Reservoirs and Irrigation Company on March 31, 1910 when this letter was addressed to him by John Farson, Jr. These letters and enclosures were obtained from files of the Laramie-Poudre Reservoirs and Irrigation Company today. Publication of articles such as letter of Mr. Campbell, attached to letter of March 31, in journals such as United States Investor has direct effect upon either purchase or inclination to purchase securities when approved or disapproved by financial papers of that character. I understand this paper is one of general circulation in financial circles.

3688 Redirect examination by Mr. Delph E. Carpenter:

The Laramie-Poudre Reservoirs and Irrigation Company was in no way concerned in or responsible for literature issued by Farson, Sons and Company in carrying out their agreement to purchase bonds of the Greeley-Poudre Irrigation District. No matter what representations were made by Farsons or how many suits may be or might be pending between them and their purchasers, that is something with which the Laramie-Poudre Reservoirs and Irrigation Company has no concern or responsibility.

I understand that a number of suits have been started or threatened against Farson, Sons and Company on account of fact that bonds sold by them of Greeley-Poudre Irrigation District have defaulted in interest owing to fact that project is not completed. If Wyoming litigation is responsible for failure to complete the system, it is also responsible in that degree for bringing of suits against Farsons.

Recross-examination by Mr. N. E. Corthell:

Farson Company is the firm that was selling these bonds and furnishing money to carry on enterprise. The Laramie-Poudre Reservoirs and Irrigation Company sold bonds outright to Farsons, but they did not take them up according to contract. They were not
3689 selling them for district or company. They purchased bonds outright. They agreed to buy bonds and pay for them but did not carry out contract.

Redirect examination by Mr. Delph E. Carpenter:

They were not the agents for the district or the Laramie-Poudre Company.

JOHN E. FIELD.

3690 Cross-examination by Mr. John D. Clark:

The reliability of stream measurements depends upon the accuracy of the various measurements both as to the cross section area and the velocity and upon the existence of sufficient accurate measurements upon which to base the proper discharge curve. The making of a few accurate measurements by a qualified person would not of itself insure the accuracy of the total record, but there must be enough of these measurements for that purpose. The
3691 measurement of stream flow requires both technical skill and experience, and the accuracy of the measurements depend largely upon the degrees of skill possessed by the observer, as well as upon the care exercised by him. In examining records
3692 I would prefer to know the character of the hydrographer as to whether he is a competent, painstaking man, than to examine his original field notes or to ascertain the character of the channel at the point of measurement. I feel that I may assume that a good hydrographer has made as accurate measurements as are possible at the time. Where results are authoritatively published, the assumption should be that they are correct, only as it is known in any particular case that the conditions were not favorable or that there was an absolute error. Before feeling justified in accepting records of stream flow, one must either ascertain for himself or must assume that the measurements were accurate. If a measurement has been inaccurate either in determining the cross section or in determining the velocity it is not worthy of faith. Inaccuracy due to faulty current meters is unusual. As a matter of precaution we test the current meters once a year before they are taken out into the field. Each meter has an individuality and must be rated.

3693 While in some cases an automatic register is used to ascertain the height of the river, the more usual method is to establish a gauge rod which is read twice a day by some observer. The correctness of the discharge records will depend, of course, upon the faithfulness with which these observers take these readings. On a stream the size of the Laramie River at its flood stage, one-tenth of a foot in height will make a considerable difference in the total discharge. The station at Woods Landing maintained by us in 1913 had no daily observations, but the hydrographer at Boswell's ranch took a reading each time he passed, which was six times in May, seven times in June, and five times in July, so that we felt that in connection with the daily record at Boswell's, our record thus gained was approximately correct. Our Woods Landing records for 1912 are acquired through a consolidation of a number of records, as there was no station maintained by us at Woods Landing

in that year. The principal basis of this record was the discharge at Boswell's ranch as ascertained by a continuous record, together with the records of inflow from intervening tributaries.

3697 With reference to the several records of the flow of Laramie River at Woods Landing, shown on defendants' Exhibit 127, I will state at the outset that I do not know who the hydrographers were, except in the years 1912 and 1913. I do not know what cross section was in any case or how many measurements were taken in each year. I cannot state the experience of the hydrographer. These matters are of record, however, and if it is desired that they be known or it is considered important, the records can be consulted and these facts ascertained. The record of 1895 was taken from reports of State Engineer of Wyoming. The information for this year derived from office of State Engineer was so obviously incorrect that I investigated to ascertain the cause. I took original data concerning discharge of river and had a rating curve and rating table constructed and then, with gauge heights as given, the discharge was determined. These records were furnished by Deputy State Engineer of Wyoming, Mr. Harry True. The gauge heights which I used were taken from the published records.

In 1896 the records were taken from the 18th annual report of the United States Geological Survey.

In 1897, from Water Supply paper No. 15, publication of the same department; 1898, from water supply paper No. 27; 1899, from water supply paper No. 39, and 1900 from water supply paper No. 49. 1911 was taken from the published reports of the State Engineer of Wyoming, his 1911-12 report, and 1913, having no published data, as I have explained, was obtained by the State Engineer of Colorado. 1912 was based upon data gathered by State Engineer of Colorado for Boswell station and supplemented by actual gauging made by or under direction of Professor L. G. Carpenter.

With reference to 1895 record, the gaugings on the stream on which the rating curve was based was from the published records of the discharge of the stream. Both the gauge height and the discharge records were published by United States Geological Survey.

I rejected the records for the years 1889 to 1893 inclusive as published by the State Engineer of Wyoming because I questioned their accuracy. If I had used the figures for these years the discharge would have been increased. Some of the computations in my exhibits I have made myself, but generally they have been made by an assistant in my office. I have not recomputed any of the measurements for the years 1896 to 1900, and have not

3699 analysed any of the figures for any of the years prior to 1912, and reduced them to their velocity and area. The 1895 record was obviously in error, because the discharge shown in September, October, and November was only 7 second feet, which I knew was ridiculous, being less than one-sixth of the indicated normal. If the discharge for more than half of this period was represented by zero in the published report, this would indicate an

error in the rating table, and not a lack of any measurement, although it would not be possible for any rating table to lead to a zero result upon the Laramie River in those months.

3700 Upon discarding the published record for 1895 and going to the original data I found two discharge measurements, one on May 24th at a gauge height of 2.8 feet and a discharge of 1,129 second feet, and one on October 23 with a gauge height of .8 feet and a discharge of 49 second feet. With these two measurements, knowing the general form of such curves and the kind of curves secured for other years, we constructed a rating curve for 1895 which I think was approximately correct, and from this made up a rating table to which we applied the gauge heights as published, and determined the discharge for each day. I do not know whether the same section was used for the measurements in 1895 as was used in the following years for which we secured rating curves, and the station was not a very good one. As the figures for 1895 are based somewhat on the curves of 1898 and 1899 it would be reasonable to investigate whether the measurements for the three years were made at the same station. I think my assistants looked into this matter.

3704 The records upon which Exhibit 131 showing the run-off of the Little Laramie River at Hatton is based are the figures for 1902, 1903, 1911 and 1912 which are taken from the geological survey publications, with missing portions of months supplied by assuming the run-off. The 1913 figures were taken from Wyoming records. I do not know anything about the character of the measuring section nor the personality of the hydrographer who did all this work, and the measurements for the last two years were taken at different points than those for the first two years. None of these tables have been re-worked by me. I have no knowledge of the character of the cross sections where the measurements were taken nor as to the individuals who took them in connection with any of the other tables which I have presented excepting in the case of Colorado stations. I have no particular knowledge as to the details of the measurements on the Poudre River either, excepting that a large part of them were under the direction of Professor Carpenter.

3705 The Skyline Ditch was re-rated by Professor Carpenter in 1903, and was fixed at very much less than its supposed capacity in former years. In my tables in connection with the amount carried through that canal for years prior to 1903 I have made no change on account of this re-rating. If those early figures are too high it would decrease the total run-off of the Laramie River to that extent, but would also decrease the amount diverted by Colorado into the Poudre Watershed and would decrease the proportion of the total run-off of the Laramie which can be diverted. The records of the flow at Glendevey as shown in Exhibit 125 for the years 1904 and 1905 are taken from the Geological Survey reports; for the years 1910, 1911, 1912, and 1913, from the reports of the State Engineer of Colorado. They were made by competent

3706 hydrographers. Some measurements were taken by Professor Carpenter, a man of very wide experience. His meas-

urements and conclusions are generally accepted without question. Some 1910 measurements by W. B. Freeman, U. S. Geological Survey, were also used. The station is well located and is equipped with an automatic register.

The records at Boswell's ranch shown on Exhibit 126 were made by the office of the State Engineer of Colorado and in 1912 and 1911 additional measurements were made by the Geological Survey. The station is fair and the channel permanent, but at high water
3707 all of the water does not pass through under the bridge, a part of it passing to the west. In 1912 the water was very high and a considerable amount passed to the west of the bridge and not through the channel of the river itself, so that in computing the discharge at high water it is necessary to add the amount passing around the bridge. I visited the station and examined the culverts west of the bridge and could see that there had been a considerable volume of water passing through them at very high velocity, so that I am positive that water did pass around the bridge and through these culverts. For this reason figures for this station for the year 1912 are not the same as published in the State Engineer's
3708 report. The hydrographer who worked up the measurements at this station is not subject to criticism, because he had no measurement indicating the existence of these added channels. I got the actual measurement of the high flow in 1912 from Professor Carpenter.

3711 The measuring station on the Laramie River at Uva, Wyoming, is below the mouths of Sybille Creek and the North Laramie River and above the mouth of Chugwater Creek. In 1913, run-off of Sybille Creek was 19,492 acre feet, between April 1 and November 22. I do not assume to make a mean discharge for that stream, but 1913 being a year of low flow and this covering only a part of the year, one would almost be justified in saying that the normal discharge was in excess of 20,000 acre feet.

3712 Drainage area of North Laramie River is about 500 square miles. I have been informed that some reservoirs were constructed upon this stream within the last five years. I do not have figures from which I could estimate the run-off of that stream.

Referring to defendants' Exhibit 145, showing run-off at Uva for several years, including 1903, in which total run-off was something less than 35,000 acre feet from May to October, inclusive, I think these measurements would indicate that water had been permitted to flow down the Laramie River from the Wheatland Reservoir No. 2.

3713 Where the question of the rights of prior appropriators and similar problems have been discussed in a report upon an irrigation project, and the conclusion is reached that a given quantity of water is available for the project, such report is taken to mean that the stated amount of water can be procured for the project with proper works, but all conditions and circumstances must be taken into consideration.

3716 In my discussion of the flow of the Laramie River I have not taken into consideration the water diverted from the

stream in Colorado and used in the upper Laramie Valley because no great amount is diverted, and it is used within a very short distance of the river and returns to the river very quickly without much loss. The same is true of the small ditches in the Centennial Valley on the Little Laramie River, in Wyoming. In my report upon the Riverside ranch my statement that the amount diverted in Colorado for use in the upper Laramie Valley exceeded 57,000 acre feet in the preceding year was obtained from the records of the Colorado Water Commissioner. It may be that water is turned on to these meadows to the depth of 12 feet in the course of a season, but the consumptive use could not possibly exceed one acre foot per
3717 acre, and more likely it would be one-third to one-half of an acre foot per acre. There would be some evaporation, but not much, because the large head of water used carries the water back to the river rapidly. Even if so large an amount does get back to the river this method of use is wasteful and excessive, just as it is on the lower part of the river in Wyoming, and on the Little Laramie in Wyoming.

3718 The amount of water diverted from the Laramie River into the Poudre River through the Skyline and Sand Creek ditches in 1911, which was a comparatively low water year on both streams, was greater than the total diversion through both ditches in the year 1912, which was a normal year, whereas in the year 1913, which was a very low year, there was less water carried through the Skyline Ditch than for four years, and no water whatever was carried through the Sand Creek Ditch. I account for this
3719 variation as follows: 1910 was a very low year, and it is probable that the reservoir capacity in the Poudre Valley was almost exhausted, creating an exceptional demand in 1911. At the end of 1911, on the other hand, some water was held over so that there was not the same demand in 1912. In 1912 the water supply in the Poudre River was so large with respect to the demand that a large surplus was left for use in the following year, so that in 1913 when the flow was but 73 per cent of the normal it was not necessary to divert any water through the Sand Creek Ditch, nor to take any place near the available quantity through the Skyline Ditch. This result was also in part due to the excellent condition of the land in the spring of 1913 due to the winter and early spring precipitation.

3720 It seems reasonable to assume that there is less fluctuation in the discharge of the Laramie River in the high mountain areas than in the plains areas, and the diversion into the Poudre Valley of a fixed amount taken from the high area will cause the fluctuation in discharge in the lower portions of the river to be more violent.

3721 The total capacity of the reservoirs in operation in the Poudre Valley in 1912 is 146,665 acre feet, including four channel reservoirs with an aggregate capacity of about 16,000 acre feet. According to report of division engineer for year 1912, amount of water stored in these reservoirs November 1, 1912, for use in succeeding season was 83,794 acre feet, which, in the report, is given as

held over from 1912 to 1913. This would leave 62,871 acre feet available capacity, by deduction from capacity given of 146,665 acre feet. If stream flow in that year had exceeded amount that did go down the river by figure I have last stated, it would have been used in lower district. As far as this district is concerned, it would not necessarily have been lost, as we have both ditch and reservoir priorities, and this surplus might have belonged, under dates of priorities, to reservoirs in the lower district on the South Platte below the mouth of the Poudre.

I do not believe that the flow in the South Platte is as similar to the flow of the Poudre as is the flow of the Laramie. The South Platte River drainage comes from an area at a very much greater distance from the head waters of the Poudre than does the flow of the Laramie, and the character of the South Platte water-shed is quite different. I think it is possible that a considerable portion of such flow would have been forced to go down the river, and further than that, the ditches on the lower river used water late in the season after November 1. That situation existed in 1912. The storage of 87,000 acre feet in 1912 indicated that there was that much available for storage in excess of use for lower district, but, of course,

I am not familiar with the conditions in 1912, as I was not
3722 state engineer at that time and cannot say that lower ditches were amply supplied in the fall of that year.

Considering Poudre as an entity, I have previously stated that any flow in excess of 62,000 acre feet above the flow of year 1912 would have been lost to the Poudre itself, with this modification, that if the flow of the Poudre had been greater than it was, diversion from Laramie River would probably have been less than it was. If there was more water than could be stored in the reservoirs in 1912, it would probably be used for fall irrigation, which is beneficial. They first seek to secure water for use late in season of following year, and bend every effort to carry over as much water as possible. Fall irrigation is beneficial, but is not usual in Poudre Valley

3724 Poudre Valley is not now in condition to take care of large floods which come down the river. These floods come in May and June and cannot be used for fall irrigation unless stored. In Poudre Valley there are times in every year when some of the ditches are short of water and the water in the reservoirs is used after June upon the lands. There would be more water used if more was available. This would not be conservation for succeeding years, but use in that year. The Poudre Valley could conserve, in high years, 146,000 acre feet for use in subsequent years. In years of large flow in Poudre River, some water would get away.

3725 If there had been a total storage capacity of 146,000 acre feet in the Poudre Valley in 1884 when the flow of the river was 666,000 acre feet from April to October, about one-half of this flow would have been wasted so far as concerns utilization in subsequent years, and in the following high year of 1885 there would have been a similar loss of about 100,000 acre feet. Where two high years occurred together, there would be an added loss.

3727 In estimating the use of water from the Poudre River, you have to consider not only the matter of storing water, but

must also estimate the direct use in attempting to estimate the amount of surplus water. In such years as 1884, a considerable amount of water would have passed out of the river, but when it comes to such years as 1899 and 1901, that is not true. It is probable that the amount of water flowing in the river in those two years was used, and the year 1902 took practically all the surplus that was held over for the other two years. There are intervals of perhaps five years that there are floods that escape from the Poudre River. If it were not for these floods and the hope of conserving this water, the construction of these channel reservoirs which the Greeley-Poudre Irrigation District proposes to build would not be feasible, even with the Laramie River supply.

3728 It requires both the surplus which occurs in the Poudre at intervals and the amount which can be brought across from the Laramie River to make the Greeley-Poudre District feasible. To try to conserve the flood waters of the Poudre and to construct these very expensive reservoirs to conserve the water which they might only get once in five years, three years or every other year, would make it not feasible financially.

3729 I have called the mean flow of the Poudre River over a period of 30 years the normal flow with the idea that it is possible to consider such flow as the amount of water which is available for irrigation. In 1912, however, no means had been used in the Poudre Valley to utilize the exceptional floods, and the mean flow avaliable for use in that valley would be considerably less than 297,000 acre feet, the mean flow of the river over the whole period. The variation between the mean flow of the river and the available mean flow in different districts will depend upon the nature of the districts, the crops which may be raised therein, and the expense of development which would be justified thereby.

The records at Uva Station show that in 1899 there were 446,000 acre feet passing that point. The present reservoir capacity on the Laramie River would conserve a considerable part of that water. Diversion by the proposed diversion system of the Greeley-Poudre would use some of that. After these quantities were deducted from the surplus shown by this Uva record, the amount would not be so enormous that reservoirs on the Laramie Plains could not be built to conserve it. Reservoir sites on Laramie Plains are very large and cheaply constructed, so that a large part of that surplus water could be used, and if the soil, climate, etc., justified the agricultural development there, such as there is in the Poudre Valley, these reservoirs would be built and practically all of that water would be conserved.

3730 I do not think it would be feasible to build reservoirs on Laramie Plains for conservation of this surplus for use on the plains. Returns from agricultural operations in that region would not be sufficient to justify it.

An irrigation project cannot be constructed upon the assumption that a low year will probably be followed by a high year, as there appear to be cycles when several low years follow each other.

The amount of water stored in the Poudre reservoirs on Novem-

ber 1, 1911, was 16,352 acre feet. As this was some time after the close of the irrigation season it is possible that this amount was stored after the close of the season, and cannot be said to be water carried over, and the same situation exists with respect to the water in storage on November 1, 1912, the large part of which was secured after the irrigation season closed. Because the amount in storage on November 1, 1911, was 16,000 acre feet and the flow of the river in a normal year exceeded the flow in 1911 by 92,000 acre feet, it does not follow that in a normal year there would be a surplus of 108,000 acre feet. I have, however, considered the amount of water in storage in the Wheatland Number Two Reservoir in the fall of 1913 as including the surplus in that year. Whether that reservoir had been emptied during the irrigation season I did not take into consideration. The amount of water stored in a reservoir several weeks after the close of an irrigation season does not necessarily indicate the surplus supply during the preceding season.

3732 Cross-examination by Mr. N. E. Corthell:

During the ten years from 1904 to 1913 the average annual run-off of the Poudre was 367,000 acre feet, of which amount 120,000 acre feet reached the Platte River, 10,000 of this from seepage from Poudre River ditches reaching the Platte River below the mouth of the Poudre and 110,000 entering the Platte from the Poudre
3733 itself. The average quantity actually diverted into the Poudre ditches would be something more than 300,000 acre feet, leaving 60,000 acre feet of original water passing down the river and 60,000 acre feet of return seepage.

3734 I estimate an average inflow into the Poudre of 10,000 acre feet from streams below the canyon. There are a number of draws into the Poudre River which I would hardly call streams, the water in which is utilized along their courses.

3735 The acreage I have stated as irrigated from the Poudre River, 265,000 acres, does not include the lands irrigated from these small tributaries. My estimate exceeds the report of the Water Commissioner of 224,000 acres irrigated in 1912 because he did not report on all of the ditches, and his report was made up from a report upon the acreage in different crops. My estimate is made up from my general knowledge of these districts, the conditions therein, and not from any survey or particular knowledge of this district.

3737 The drainage area of Stuck Creek, a tributary of the Laramie River, is 33 square miles, all of which is in Colorado; that of Johnson Creek is 13 square miles, practically all in Colorado, and that of Beaver Creek is 30 square miles, of which 9 square miles is in Colorado. The drainage area of these three streams is similar, but Beaver Creek and Stuck Creek have a considerable amount of high drainage, and Johnson Creek does not. I am not entirely satisfied with the division of the drainage areas as shown on Exhibit One, as I cannot reconcile the reported discharges with the drainage areas as there shown.

3738 If the drainage areas as I have stated are correct, it would show a run-off of .42 feet from the drainage of Stuck Creek, 1.9 from the drainage of Johnson Creek, and .6 feet from the drainage of Beaver Creek. A slight error on the part of the geographers would account for the discrepancy. Taking the three streams as a whole the average run-off would be about three-quarters of a foot, which is one-quarter of the run-off at the head of the Laramie River. That part of the drainage area of McIntyre Creek which would be diverted by the Greeley-Poudre system would have a run-off of about one foot.

3741 My estimate of the drainage areas of these several streams is based upon such information as I could secure from the Geological Survey, from the Forest Bureau, from Professor Carpenter and Mr. Meeker. I have not, however, based my estimates of the discharges upon these estimates of the extent of the drainage areas, but upon actual discharge records.

3743 These three creeks run off earlier in the season than the main stream. The seasonal and diurnal flow varies in all of them in about the same manner, I believe, and the diurnal fluctuations are perhaps twice the fluctuations on the main stream. I estimate that the depth of the annual run-off of the general territory covered by the drainage of these three streams will average about one foot.

3747 The data relative to the run-off of Sand Creek is meagre and unsatisfactory. From such records as I could find and upon an estimate of the run-off of the area and similar areas I estimated the annual run-off of the drainage basin of Sand Creek as 17,000 acre feet. I do not know of Sand Creek having at any time contributed any water to the Laramie River. I think that for many years the water of that creek has been drained into Hutton Lake.

3749 Aside from the measurements made by Mr. Meeker at the Pioneer Dam of the winter flow of the Laramie River, there was a measurement made late in October, 1905, showing a flow of 49 second feet and the river remained at approximately the same stage until the end of November. Measurements were made at Glendevey on October 7, 1911, and October 18, 1911; at Boswell's ranch on October 8, 1911, and a little below the Greeley-Poudre tunnel in February and March, 1914; also near Glendevey on November 6, 1910, and at Boswell's ranch on November 8, 1910. These are all the winter measurements I have, aside from those of Mr. Meeker.

3750 I have no data as to the flow of water from the drainage area of the Laramie River north of the Little Laramie, for which I have allowed an average annual flow of 12,800 acre feet. This area is drained almost entirely by Seven Mile, Dutton, and Cooper Creeks, which are tributaries of James and Cooper Lakes, and by Four Mile Creek, which is much smaller. So far as I know there has never been any flow of water from James and Cooper Lakes into the Laramie River. The territory from which I have estimated

this run-off of 12,800 acre feet also includes the mountain territory east of the Laramie River and south of the Wheatland Reservoir. In this region there are Willow, Five Mile, and Soldier or Government creeks and some unnamed gulches and canyons. I do not know how many years it has been since water has reached the Laramie River from either Willow Creek or Five Mile Creek. I have no data as to the run-off of any of these streams or gulches, and my estimate is based upon an assumed run-off of the area in question.

3753 The only data relative to the run-off of Sybille Creek was obtained from the State Engineer of Wyoming, and the discharge curve was calculated in my office.

3754 The saturated areas on the Laramie Plains aggregating six thousand acres of which I have testified, include areas over the whole district which I cannot locate by section. There is one large area extending about 15 miles on each side of the Pioneer Canal, and I believe that the total area of saturated land exceeds the 6,000 estimate by at least 4,000 acres, and that in addition there are 6,000 acres of unused water surface receiving water from ditches on Big and Little Laramie rivers. I believe the evaporation from these areas will equal six feet a year, and I have estimated four feet of evaporation over the whole area.

I have noted the method of irrigation on the Sodergreen ranch and on the meadows of the main Laramie River in 1913, but not under the Pioneer Canal.

3761 LOUIS G. CARPENTER, recalled:

Direct examination by Mr. Delph E. Carpenter:

Facts relative to run-off of water from any area of earth's surface has developed into pretty well defined method of measuring quantity of water by aid of current meters. These meters are a little bit akin to windmills, as to form, that is, they are some sort of a wheel that is actuated by movement of water and will go faster as water goes faster, so that they give a means of measuring velocity of water. Then, with cross-section ascertained, the factors give means of obtaining the quantity.

3762 There are other methods of measurement of larger streams and, even with moderate streams until a few years ago, other methods were generally used. It has only been within past few years that current meters have been available as instruments of commerce. There used to have an old German wheel on same plan called Woltmann wheel, and first one used in this western country was commonly called "Colorado Meter." This consisted of a wheel about 10 inches in diameter and it was this old Colorado Meter that was used to rate streams in Colorado from 1883 to 1885. First one of this type was made in 1883. Since that time there have been other and more convenient forms in use. These are especially applicable where streams are not very deep, which is case with most of our streams and ditches here. Before that time it was quite com-

mon to use double floats as in Humphrey's and Abbott's Gaagings of the Mississippi and in quite noted series of experiments in India at Roorkee, experiments by Cunningham, and sometimes flumes or channels of very nearly uniform depth are used, by vertical rods and sometimes by floats. The double float in particular was that of a float that might be a little heavier than water, and would float along in current and indicate velocity of water wherever float was sunk, its position being indicated by a marker on surface which was another float. With great depth of water this double float brought considerable trouble.

Of all those methods, the meter in the past few years has become an instrument that deserves a great deal of confidence. Nat-
3763 urally these were developed in last 20 or 25 years largely because of western needs. The meter was not considered a very reliable instrument. I had the second Colorado meter and used it for a number of years and tested it a number of times and found it was really very dependable. I refer to the original Colorado meter. The name was afterwards applied to another meter of similar size. The Colorado Meter was the old meter with a large wheel of which I have spoken.

In principle, all of these meters are such that speed of wheel increases with speed of current. They need a means of starting and stopping the counting gear and they need some means of counting the revolutions. This is sometimes done automatically by gears or counters and these may be thrown in or out of gear at specified time because in determining velocity, this rate of wheel must be obtained or, in other words, number of revolutions in a given time and of course some means of holding the meter, which in larger streams may be done by rod or in deeper ones by wire or some means of that kind. Along with the meter a means of determining depth of water and of ascertaining time is used. Time is determined by a stop watch that can accurately record seconds and fraction of a second.

In practice those instruments which have recording gears, would be thrown in gear and watch started at same time and at end of period both thrown out of gear at same time. That gives number of revolutions and number of seconds and hence number of revolutions per second.

3764 In order to turn that into velocity calls for an independent series of observations. If we have one revolution per second, for instance, that does not give number of feet per second water is flowing, unless you can conver- that from revolutions into velocity and that calls for a rating of the meter.

Each meter has a rating of its own and each one needs to be tested to be entirely worthy of confidence and that in part is done by moving meter at different speeds through still water and involves supposition then that if water is stationary and meter moves at certain speed, effect on meter is same as if meter is stationary and water moves. From a series of observations of that kind, means of converting revolutions of wheel into velocity is ascertained.

They use same system as has been used for years in anemometer of

Robinson pattern, which is used by all weather bureau stations, but it has also been known for years that the assumed ratio was not correct in these, or rather, that at high velocities relation between velocity of wind and movement of cups was different. So that in current meters, same thing is true, but a rating reveals these various ratios and every meter needs to be rated, as it is termed. The factor depends largely upon diameter of wheel, that is, number of feet of velocity of movement of current to cause one revolution of wheel. thus, in old Colorado Meter, it took about eight feet of movement of water to make one revolution of wheel. In smaller moderate sized meters, it took about 4 to 4½ feet and in some of smaller wheels used at present 2¼ to 2½ feet.

Ease of movement of wheel of course affects ratio slightly, but not very much. I mean, if pivots become rusty it would be
3765 supposed that wheel would move harder, and thus rating be affected, but in many tests I have made of same meter under different conditions, I have not found much difference from these causes, and I do not think there is much reason to take those into account, so far as mere rust is concerned. I have had one meter in use practically twenty years. I have tested it at different times under different conditions and the rating curve was very little changed. These all relate to meter conditions.

There are some other meters of an electrical type, where meter records by breaking or closing an electric circuit, either every revolution or every 5 revolutions or 10 revolutions, as may be arranged, are recorded and I have also used meters that simply made and broke the circuit with a counter on the outside. They were not very successful.

There are also what are termed acoustic meters. They all use the varied means of determining the number of revolutions the meter makes, which must be determined in connection with a stop watch or a watch of some kind and also with a rating table.

The hydrographer counts the revolutions with electric meters. Most electric meters make and break the circuit and that making and breaking is indicated by its connection with a telephone which as at observer's ear. It causes a vibration of the diaphram and a little click. The observer counts the clicks. In case of self recording meters he reads the dial and of course the electric ones of present pattern involve counting. This counting is done by hydrographer.

In the making and breaking of the electric current of the counters, the armatures, magnets, cannot work with more than a
certain degree of speed and I have found with some of these
3766 meters, such as we had, that when they got up to 8 or 10 feet per second, it simply did not work. I have used them in 12 and 15 feet velocity on the Poudre, or rather tried to. In the pattern which I tried, which is not same as now used, magnet would be magnetized and bring down armature and between breaking of circuit and next formation of circuit magnet would not be magnetized enough to let loose and they simply refused to record.

In use of meters that record at every revolution, in seeking to determine high velocities of water, it then depends on the skill of

the observer in counting these clicks. With a meter like the Price and Lallie pattern, which makes one revolution for about 2 feet per second, if the current is running 9 feet per second, which is not an uncommon velocity, the wheel would then revolve 4 times in one second. Hence the observer, if the meter is one that records every revolution, must observe these 4 clicks per second and count them accurately, and, as these clicks are not sharp and distinct and are a little prolonged, it becomes a matter of some difficulty to do this counting accurately.

It is for that reason that meters I have used of that kind, I have had made so as to record only once in every five revolutions. With this instrument, the click is made about once with every 11 feet of velocity. One per second in 11 feet velocity is not difficult to record.

With meter which records once for every five revolutions, hydrographer does not have to possess experience and skill required in counting for meter recording for every revolution. He is not
3767 so apt to lose count. With greater velocities, person would have to be very skillful, in fact, it would be very difficult for him to make a clear record at all.

Even if he could, then there would be that problem of counting four or five times per second, which, as far as ordinary person is concerned, cannot be done. Two or three times a second would be as much as person could ordinarily count and it is very easy *them* to lose clicks and to fall short. So I think meters which record less frequently are much to be preferred when recording higher speeds.

It is to be remembered that meter is simply an instrument to determine velocity and that it determines the velocity at the point or place where it is held. Where one wants to be as accurate as possible and where time is available, it is of course most conclusive if he holds meter at every point in current across whole cross section. By this method data for determining average velocity for whole cross section is obtained.

It is known that current in a stream is varying. It is faster in middle than at sides as a rule. It is faster at top than at bottom. It is not as fast a little below surface as at surface. Hence it required to get the mean of that varying velocity at all points in the cross section. Now that point method carried out to extreme limit, would involve ascertaining all of these points, it also involves supposition that stream has not risen or fallen during that time, that is, stream has been stationary in height. Consequently in our mountain streams, that involves a supposition that is not true, for it
3768 takes time to get a measurement and the stream changes. Hence it comes to comparison between extreme accuracy or care of that kind and an approximation. Sometimes a systematic approximation is made. In fact all methods have some approximation.

Ordinarily a system of vertical integration is taken, if observer has a limited time. In this system meter is held at certain spot and raised and lowered from surface of water to bottom, so as to get velocity in that particular vertical line. This then may be repeated at different intervals. Usually the spaces are uniform. The area of

these sections is then found by measuring the depth in each section and adding. In raising and lowering this meter vertically it is attempted to have meter travel with same speed as it goes up and down, so as to get general average of velocity. It is quite important to do that. It is important that meter should not rest longer in one place than in another and, in addition, with the form of vanes commonly adopted, speed must me moderate because as they have a slope to rear, if meter is raised and lowered rapidly, it will be found in still water vanes will move backward. In other words that brings in an opposing force that cannot be met. In case of streams of uni- from depth all way across, like flumes, this may be done with equal accuracy by making an integration clear across stream from one side to other in one reading.

Where approximations are noted, and an approximation may be sufficiently accurate at least to serve the purpose, the meter may be held at certain points in the depth in the current, for instance .6 of depth from surface to bottom is a point where is usually found average velocity of current. I mean that by taking a series of tests,

the velocity at .6 of depth is found to be from 98 to 102 per-
3769 cent. That percent. of velocity of whole vertical section.

Measurement is made from top. This does not mean to say that in any particular case that is true, there may be many cases where it is not true. This method is commonly called .6 method. It is measured .6 from surface downward. It would be equally as reliable to take velocity at any other point and multiply it by a factor, hence, surface velocity is about .6 percent. in cases of average velocity for that vertical section and of course it would be equally as accurate to take that and reduce by corresponding factor. That is, equally as accurate as .6 method. They both depend on averages and may be far out for individual cases. Just as you know as a matter of average in insurance, that a man 40 years old will ordinarily live to be 68 but it don't mean that any specific individual is going to do it.

Either the .6 method or surface method of computation is subject to great irregularities in individual cases. Especially so in mountain streams or streams with rocky bottoms. Streams of this kind have more or less rocks and these set up irregularities which are shown by boils, as we often speak of them. They are vortices and these appear on surface of water and break. The cause of that may be a rock that is quite a distance upstream, depending on speed of current and character and depth of rock. The water will not break

and boil on surface immediately above rock that causes it in
3770 first instance and the person observing stream will observe

that these boils do not reappear practically at same place in stream. The cause of the boil is above.

Nearly all of these averages used with either six-tenths or surface method and those determinations suppose that onward progress of stream is undisturbed, so that while these methods have their use within their limits, yet, they have to be taken with their limitations.

If surface method is used meter must be placed at various points on surface of water entirely across stream in order to obtain mean

surface velocity owing to fact that velocity of water is greater at center of stream than at sides.

Determination of maximum surface velocity, is still another method used commonly where no meters at all are available. This is usually done by putting in a float that goes with the current, partly submerged, so that it will not be affected much by wind. Time it takes to pass over a given distance is found and that is multiplied by a factor which may be anywhere from 65% to 95% or even more than that in some cases. Each individual case has its own factor, although they are fairly well classified, that is, where streams are fairly regular factor may be from 80% to 87% in order to strike average, if it is in fairly good condition. For some purposes to meet certain conditions this method is fairly satisfactory. But the more irregular the stream is the more irregular is the current and the more the stream is disturbed by irregularities
3771 at the side by irregularities on bottom from rocks or anything of that kind, and the more uncertain this coefficient is, because the selection of it is a pure matter of judgment and not a matter of conclusion from observation. Methods of six-tenths or two-tenths, eight-tenths, etc., are essentially the same and all depend upon the supposition too, that particular case is an average case. If in fact case is an average one assumption will give pretty good results. The more it varies from average case, which is pretty difficult to tell in case of water, the more unreliable it is and it does not have the conclusiveness of more extended methods.

Either the six-tenths method or surface velocity method involves the judgment or conjecture *or* hydrographer as to what factors shall be used in connection with these velocities which are determined in ascertaining average velocity of stream. In using meters for years, as I have done, I have in cases without number taken pains to also measure surface velocity, or velocity at different places, to obtain a basis for comparison between these methods of measurement and the average that would be found and out of it all I have arrived at conclusion that, except in very regular channels like flumes, the factor was a very uncertain thing. I was studying the matter to a greater or less extent, and in many of these cases I made an estimate before taking the measurement, as to what I thought the factor would be and the result generally proved that the factor was quite different and yet no very apparent reason could be seen why it should so vary. In nearly every instance the factor was a
3772 matter of uncertainty. I have by accident conjectured the factor that later proved to be correct. This did not occur with frequency. As a matter of probability you would be just as likely to choose the exact one as any other of the specific number but the obtaining of it was apparently as much a matter of luck as certainty. It was not certain, although I may say this, that in flumes and regular channels the limits generally are not very wide. In mountain streams limits are quite broad. There are so many conditions you cannot see and do not know, for instance, take any-

thing like eddies in current which at first give the appearance of greater velocity. As matter of fact the velocity very rarely comes out as high as it appears in those cases.

There is no uniform factor for determination of average surface velocity of stream by measurements taken on sides alone. That is particularly a factor that would be affected by roughness of sides and bottom. Of course 40 or 50 years ago, they were attempting to calculate flow of water without taking roughness into account, but they found out after taking the experiment of D'Arcey, that roughness was a factor and this is recognized in all the formulae for computation of flows and of course that would likewise indicate a priori that the velocities and distribution of velocities across the stream would be affected by the sides. That is borne out also by observation. I do not know that anyone has ever attempted to work out the rule accurately and, with the labor that would be required to
3773 ascertain that relation with any degree of definiteness, it would not be worth while because labor involved in that could be avoided by using a little different method. It would be an enormous labor to develop the rule, in fact would depend upon depth, roughness of sides, speed of current and various other factors and I do not think it would be worth the effort.

If a measurement were merely taken on one side of a mountain torrent and at the surface, of the water, a computation of average surface velocity of water would have a large latitude of possibility of error in it. It would have even more latitude of error than would prevail when obtaining velocity by surface method as compared with integration method. It would be more comparable with surface float method. It is more analogous to taking of one measurement and estimating velocity at all other places.

The one-point method so called, of obtaining velocities with meter is generally the same as the six-tenth method. The taking of velocity at one point in each section. The stream is divided into sections by any method, to determine the velocities with that method. You divide the stream into parts and the velocity in each part is found or inferred from observation taken.

3774 In using two-point method, so called, meter is held at two points in vertical section, in a vertical line, and from those velocities found at those two points, average is inferred.

In all these cases it is, to some extent, a matter of inference and presupposes that the particular case is an average one. Curves are drawn that are the average of a large series representing velocity at different points and if then average can be depended upon, why of course such a method would be reliable. I do not mean to say that these methods are not justifiable under certain conditions. I have used surface float a good many times where it was perhaps curiosity I wanted to satisfy, rather than to make exact measurements, when time was short and where conditions were particularly good, but I had to use it always with recognition of fact that it was not very conclusive result that was reached.

Integration method, which I have described, is from my experience generally accepted as the most accurate and satisfactory of all

the methods employed and I think that has also been experience among hydrographers, that they would prefer to use that method where they could, considering time and accuracy and confidence that would be given. If large averages are to be taken into account and streams flow can be considered as a whole, or in large numbers so that average could be considered, why, of course, one of other methods like six-tenths method might be available for that purpose. But where you want to get measurements at a particular station and want to have confidence in that result and have best results for time which is available, I think vertical integration
3775 method is the most satisfactory. Of course the distance apart at which these are taken are matters somewhat of judgment and depend somewhat on breadth of stream. In stream that is 20 feet wide, measurements need to be relatively closer together, so that final result will be within a certain percent., as compared with stream 100 feet wide, where measurements may be further apart and yet percentage of accuracy be same.

Before run-off can be accurately ascertained following facts need to be determined:—Rating of current meter needs to be known accurately and all these measurements also involve question of cross section of stream. Cross section is a factor of depth and hence depth of water needs to be determined from point to point across stream and, from quite extensive experience, I am inclined to think that as a whole as great a percent. of errors is due to errors in obtaining cross section as in obtaining velocity and yet, in most cases, hydrographer considers cross section measurements as a secondary matter. More than that, in mountain streams water is fluctuating constantly due to waves. It may vary five or six inches or more within a few minutes as a wave passes, that is, water rises and falls with these waves and hence a person may make errors in obtaining depth because he does not determine just what is height of water. When depth, cross section and velocity is determined, quantity in cubic feet per second or otherwise is merely a mathematical calcula-
3776 tion. It is subject to errors of computation and, of course, is subject directly to fact that any errors that may exist in determining depth or rating curve of meter, would bring an error in corresponding factor.

It is evident that in measurement of a stream or ditch, it is impracticable to measure stream at all depths. A person measures it when he is present or goes there and is practically confined to what he finds at that time. It may be that a person with a meter can go there only occasionally. The distance may be too great and consequently he may make measurements at certain times, not selected times, but necessary times.

Rating curve as it is called, is then, a curve formed from these observations so as to enable one to determine quantity of water that passes at any intermediate time. If one knows height of water that is the purpose. Method in making rating curve is this: Observations are taken at different times, having depth given at each observation and quantity of water is then determined. Then after

platting to scale on cross section paper or similar paper, it is found that these elements will fall into a more or less regular curve, that is by using the paper so as to use the depth for instance for the abscissa or vertical scale and the quantity as ordinates or horizontal scale, they they fall in a curve. This curve is usually essentially a parabola if the station is a good one, that is, where the current is regular, the channel straight and regular in other respects. In such case the points which register these observations will all fall on a very definite curve.

3777 If channel is irregular, conditions not so good, or if observations for any reason are not so good, the points will diverge more or less, or if mistakes have been made, and in any event, certain errors are found in all observations, these points will generally diverge slightly from simply a regular curve. They depart less as observations are better or conditions are good.

Task of person working up observations is to draw a curve that fits these observations, and as curve is so regular, it is possible to determine quantity of water for intermediate depths with a great deal of accuracy. If these observations diverge from a regular curve, then accuracy of curve is not as great and one's inference as to flow for corresponding depths would be more uncertain. That is particularly the case with mountain streams, observations are not so good, do not fit the curve so well as with streams under better conditions. But taking it altogether, they give a fair means of estimation of quantity and these curves so made are called rating curves.

If curve is extended beyond depth where measurements were made, then this extension becomes more uncertain still. but between high point and low point, inferences are pretty good. Outside of the high and low points, it is more unsatisfactory and may be a good deal a matter of chance. Curve should be used to ascertain quantities at points intermediate between those where observations have actualy been taken, but sometimes, from necessities of case, those quantities have to be taken from point outside of those actually taken. In such case it should be recognized that range of

3778 error is very much greater. Where there is lack of satisfactory data of run-off in any particular region, it comes then back to a matter of judgment and knowledge to a great extent. I mean by that, as to manner in which person might obtain most dependable conclusion.

If there are records of adjacent streams, these records may be guides as to quantity of stream under consideration. The nearer that adjacent watershed is in character, in elevation and in other conditions as to rainfall, etc., why of course the more nearly they serve as a just basis for deduction. It is necessary to use this method more or less. Of course most satisfactory method is to have long series of records on stream under consideration, but that is a very rare thing.

Assumption of average flow of any stream from records obtained from 1, 2 or 3 years' observations, is subject to exactly same errors as would be attempt to obtain average precipitation at a place from 1 to 3 or 3 years' records. It is a fact of the same general character,

is subject to influences of weather, and therefore record of any one year may be exceedingly misleading, notwithstanding it may be a valuable fact together with other facts for a basis of estimating run-off. In those cases too, any comparison of relative size watersheds is a matter to be considered, for floods are not in direct proportion to size of sheds, and hence, as far as maximum flow is concerned, they are not in same ratio as size of sheds. Of course, person would then have problem of forming some kind of conclusion as to run-off as very often comes to engineers. All items of information that bear upon the subject are considered and given weight. Comparison with other watersheds that do have records is one method
3779 and question of precipitation, if available, may have a very important bearing but in mountain regions that is very rarely to be had. Records of that kind are rare.

The Laramie River and Cache la Poudre River are adjacent streams, at least at their headwaters and is a case when general conditions are parallel and one of the cases where the conditions that have affected one do affect the other to a very great extent. It is probably one of the cases where inferences can be drawn much more certainly than in many others that might be mentioned and whose watersheds are as close to one another. While it is true that Laramie watershed is on opposite side of Laramie range, yet both are on east side of main continental divide. To attempt the same comparison between west side and east side might be as safe, although even then such a comparison would be valuable. The fact is, that Continental Divide extends around south and west of combined drainage area of the two streams. The intervening range between the two streams is low and none of it is above timber line. The same general conditions of precipitation affect, for all general purposes, two
3780 watersheds substantially alike.

Annual precipitation of Laramie, Wyoming, as given by previous witness, is not same precipitation as prevails at Centennial, Wyoming and is not necessarily representative of Laramie River Valley. Centennial is in Laramie Plains, but in that branch of Laramie Plains Region that is spoken of as Centennial Valley, that is, it is in the Little Laramie Drainage at foot of mountains on edge of plains. It is a part of main plains but on west edge.

Precipitation at Centennial is almost twice that as Laramie. If record is taken at Centennial by years and compared with record at Laramie by years, the difference would not seem to be nearly as great as it actually is. The reason, however, is apparent, that the record at Laramie and the record at Centennial are not for the same years or months, or rather, the record for Laramie is for a much longer period of time and consequently the average as deduced at Laramie includes a great many years where there is no record at Centennial. If we take a record at Centennial and on identically the same month take one at Laramie, we have up to two or three years ago, when I made the comparison, the average at Centennial as 15.97 inches per year. Now if we take identically same months for Laramie that we have records for for Centennial, we find that precipitation at Laramie at that time for those months was 8.98

inches per annum, or precipitation at Centennial is practi-
3781 cally 1 4/5 that of Laramie for same time.

The ratio is the basis for comparison rather than the average for a series of years where the years are not the same in both places. That general comparison is also true, for instance, between Hatton and Laramie where we have nearly four years' record at Hatton, a little better than four years, it is four years and five months, we find that while average at Laramie for those months and years was 10.37 inches, at Hatton it was 20.51 inches, which is almost twice as great. In other words, that is simply an illustration of general fact that in a valley of that kind, surrounded by mountains with a relatively flat bottom, precipitation changes as you leave that point and thus record which is exceedingly valuable, is nevertheless a record for that particular point and is not necessarily average for valley. In fact it is not. It might represent a stretch along on that side, but amount is changing very materially from place to place and especially as you go up into mountains on either side or go up nearer mountains.

In fact an inference made from that would be just as unsafe and just exactly same character as an inference of flow of stream from one point of observation on the stream. Precipitation is varying and of course it has long been known that precipitation changes as you go up into mountains and that mountain records are generally lacking. I have established a great many stations on eastern side of Continental Divide, especially in Poudre Valley and Big Thompson Valley. I have had rain gauges outside plains at Manhattan, Livermore, Elkhorn, which is east of Manhattan, at a place
3782 north of Manhattan and at Home postoffice. My rain gauge at latter place was a few miles from Zimmerman's where Home post-office is located. I sent one at one time to Home post-office, but got no results. I had one at Gleneyre on Laramie River for a number of years. Also one in North Park near Walden. The one at Walden was kept about 15 years. These records at Gleneyre were made from 1896 to 1902, practically 6 years. Record at Centennial, Wyoming, would overlap the Gleneyre record about 3 years, but I did not make any comparison between the two. If Gleneyre record is compared with Laramie record in same way as was done with Centennial and Hatton, that is, taking those months on Laramie record and those same months on Gleneyre on Laramie River, we have total for year at Gleneyre as 12.56 inches and at Laramie for those same months 10.15 inches, or that rainfall at Gleneyre is about 25% more than at Laramie. Gleneyre is in bottom of valley near stream, near the thalweg, that is, the place where the stream goes, but on other hand its elevation is considerably above Laramie. It is in Colorado south of Colorado line but is relatively low down. Gleneyre is only station we have in Big Laramie Valley in Colorado and, so far as records are concerned, only basis of judg-
3783 ment for comparison with Laramie and for comparison with Centennial and Hatton in Little Laramie Valley. In this case Gleneyre is only 25% higher than Laramie, while Centennial

and Hatton run from 80% to 96% higher. So far as these lead to an inference, and subject to same general limitations of course, shortness of record, rainfall at Gleneyre would be less than rainfall at Centennial or Hatton.

This would indicate that Little Laramie watershed is better contributor of water than Big Laramie river, so far as these observations go. Of course Gleneyre is only one point in Colorado portion of Big Laramie and it does not represent average of Big Laramie watershed in Colorado any more than Laramie record represents average for Laramie Plains. But it does perhaps give a pointer which taken together with other appearances, might give basis for drawing a conclusion of that kind.

Importance of Little Laramie watershed as compared with Big Laramie watershed, may be judged to some extent from appearances, more particularly from records obtained from measurements of snow, where as matter of fact in mountain watersheds it is almost impossible to get rainfall records. People do not live at high elevations in first place and in second place those who do live there are not particularly interested in this kind of a record and they generally cannot be interested either, so that next method I have used to quite an extent has been observations of snow fall as a means of at
3784 least getting winter precipitation, for it would be on ground for sometime while rainfall passes off at once.

There is a very heavy precipitation of snow on Medicine Bow Range along Little Laramie River. A very heavy precipitation. And it seems to be as large, and I do not know but larger than certainly a good part of Laramie watershed in Colorado.

Records of run-off of Cache la Poudre River have been kept for quite a period of years. Poudre River has longest series of records and most continuous series of any stream in Colorado. I have already stated that that stream is, for all general purposes, practically parallel with the Laramie. Record of run-off on Poudre River started systematically with 1884, with about one month's record in 1881. It has been practically continuous since 1884. In 1884, '5 and '6 it was kept under direction of Mr. E. S. Nettleton and was started by ditch users in valley. They subscribed about $3,000 to put in a floor and formed a rating station by subscription among the ditches. Object was to make a regular section and to avoid discrepancies from roughness of bottoms, sides, etc. The floor was made of timber and poles and so floored as to regularize the flow. So constructed that bottom of change would not change and that cross section would not change in character. This was done at solicitation of Mr. B. S. LaGrange, who was Water Commissioner, one of the first in Colorado, and one of those having a great deal to do with development
3785 of system of supervision. He was also a man of advanced ideas along those lines. It was also his idea to put in a telephone. The ditch companies raised $3,500 by subscription for such a phone.

Poudre rating station was established by them and Mr. Nettleton put in a recorder for 1884, 1885 and 1886. In 1888 or 1889, this was washed out. I made measurements there myself in fall of 1888 and, when I found in 1889 that State Engineer was not intending

to continue the instrument or to replace it after it had been destroyed by the flood, then I took charge of it by furnishing an instrument from the experiment station and maintaining an instrument there from that time until I left the experiment station 2 or 3 years ago. Poudre records were kept with an automatic instrument that was very sensative. Its records were, as a whole, very excellent. I sent a man or went myself once a week to change the paper and to see that the pen agreed with the height of water and to make gaugings of stream at various heights, so that as a whole we made I presume without having counted them 100 to 150 different measurements of the stream were made with meters, which served as basis of the rating curves. Subsequently this flow was washed out and the sides and timber rotted, but in that case then a masonry wall was constructed and same place has been maintained as a rating station. The
3786 floor was not re-established in the new station. Proper consideration of the change was made in determining the quantities. The new station was not quite as satisfactory as the one with the floor, because it changed to some extent with rise of river. While water would tend to wash out certain parts, but as a whole the record was a very excellent one and became especially valuable as being the longest record of any stream subject to irrigation and also the most continuous. Later on in the winter season I adopted a practice of sending a man up once a month or thereabouts, to make observations of conditions, when it was covered with ice, but in first few years there were no winter records. They were not very satisfactory as compared with run-off during summer.

Taken as a whole, I do not know of any stream in the west where records have been as carefully kept as at the Poudre River station. Reason for this is that it was not taken up for any commercial purpose or affected by any commercial considerations, but for a desire to get out the record and to keep it, all of which seemed to be a matter of public importance. Many of the other stations have been abandoned as persons responsible for them thought that they were against their interest or had not the funds to maintain them. I could use experiment station funds and was going to, but, as matter of fact, it did not involve much outlay except we had to buy several instruments to replace those that were washed out by floods. I resided 14 or 15 miles from the station. It took a good portion of one day of each week to tend to the station. At one
3787 time I put in a self recording instrument and ditches of valley put up a wire or telephone or what might be called a telephone wire that connected stations with my office so as to record heights in my office.

I kept Poudre Station under my personal supervision during this long period of years purely for scientific purposes. I started I think in 1889 and dropped it in 1910. About that time office of State Engineer had more funds available for such purposes and they were able to take up responsibility of additional stations. It is almost certain that history of water flow in Cache la Poudre River, as recorded by Poudre Valley station over that long period of years, could, for all practical purposes, be taken as generally similar to

the history of the flow in the Laramie River in the same general period of years. It is of a similar character, subject to the same fluctuations and the same relative fluctuations as the Laramie. Of course they have their individual rises and falls from local storms, etc., but as far as general conditions are concerned, the two streams are subject to same conditions. They have some snow fall of higher regions and general rains would affect both. Local thunder storms might affect one and not the other.

When Poudre River Gauging Station was first established in 1884, it was above all existing ditches except North Poudre Canal, which took very little water and irrigated a very small tract of land. I might also state that a little ditch known as the Route Ditch, sometimes known as the Canon Ditch, was also located above the station. This ditch fell into disuse at about the time of the establishment of the station. It had long flumes that were difficult to main-
3788 tain and it did not carry very much water nor very continuously.

Previous to 1889 some water was diverted across the range of mountains from Michigan River into the Poudre River. Later water was diverted from the Laramie and the Grand. Later on the North Poudre System increased its diversion from the stream, constructed reservoirs and it extended to cover an area it originally contemplated to cover and it took more water from North Poudre that would otherwise have gone through this gauging station. The Poudre Valley Ditch was constructed along about 1903 and this starts above gauging station, so that the water that is diverted by Poudre Valley Canal is then abstracted from the river as it passes the gauging station and correspondingly reduces the flow as registered there.

Water that comes from Sky Line Ditch, Michigan Ditch, Mountain Supply Ditch and Grand River Ditch, all comes into main stream and goes through this gauging station and increases water there by corresponding amount so that the effect in operation is that these mountain diversions increase the amount and the North Poudre and Poudre Valley Canals decrease the amount that is measured at the gauging station. And in getting the amount that comes from the Poudre watershed alone, the North Poudre and Poudre Valley diversions should be added and the inter-mountain diversion subtracted. The quantity of water diverted by the North Poudre and Poudre Valley Canals above the rating station prior to 1904
3789 would be about the same as the quantity brought into the watershed from foreign watersheds. The North Poudre was not using a large amount of water prior to that time and Poudre Valley was not using any until 1904. Prior to that time the Grand River Ditch brought over some water but it was small. The enlarged Grand River Ditch did not deliver water into the Poudre Watershed until 1904. Generally speaking, I think the amount of water passing the Poudre River Gauging station from foreign watersheds prior to 1904 would about offset and make up for that diversed above the gauging station by the North Poudre and other canals prior to that

date. It would not make much difference one way or other. It would not make a difference of over 1 3 of one per cent. anyway.

I encouraged measurements and investigations of run-off of Laramie River in Colorado above Woods Landing, Wyo., in 1903 or 1904 and some were taken up by U. S. Geological Survey and Mr. Lamb was put in charge of that. Mr. Lamb had been a student of mine and he spent two summers on Upper Laramie and in North Park. I gave him such encouragement and advice as I could. Mr. Lamb is a competent and careful hydrographer. At that time he was a student and had not had a large amount of experience, that is, he graduated in 1902 or 1903 and I think this was his first independent work, that is my impression. He was working at that time under U. S. Geological Survey. Notwithstanding he had not had great amount of experience he was competent and could be entirely relied upon.

3790 Whatever statements he made are the facts. I think he could be absolutely depended upon. He had a good foundation, which has shown in the results, and has shown in his subsequent career. He was a man of good judgment and I took what he said with a good deal of confidence. He has remained with the water resources branch of the government ever since and has been promoted and given positions of greater responsibility, showing also that he has the confidence of his Bureau and of the officers with whom he is working. Mr. Lamb made observations during year 1902, 1903 and 1904. He had stations at what he called Jelm, which really was Decker's and at Glendevey on Laramie River. I believe he also measured McIntyre. Don't know what he did on other streams, he was spending practically all his time there at those stations. I believe he kept a constant record.

Decker's station is very close to Boswell Station, a little above it. Boswell Station is on Main road across Laramie and on one of roads leading to North Park. Decker Place was at the Decker Ranch house, which is not far above Boswell's, perhaps ¾ mile. Boswell's is in Wyoming and Decker's is in Colorado. There is a private bridge at Decker's and Mr. Lamb had a self-recording instrument.

3791 The box in which the instrument was placed was still there the last time I visited that point. After the U. S. Geological Survey had ceased these measurements I furnished an instrument to Mr. Decker and he kept records there later. He became water commissioner and also carried on some special observations for me. Mr. Decker took a good deal of interest in this matter and especially in connection with his duties as water commissioner. He was of a careful and pain-taking disposition. Later on I had occasion to compare these results and, in 1912, I carried on a good many measurements up there individually and with aid of assistants. Subsequent to time Lamb went there, Mr. Decker kept records at Decker Station. I think later, 1908 or 1909, there was one year of records at that station. There was one year when I furnished an instrument and I don't know but two years. By instrument I mean an instrument that records fluctuations of stream, charting, so that pen moves up and down as stream rises and falls, thus with those

instruments of that type, if record is good, you can determine fluctuations of stream in between. It is equivalent to a continuous reading of gauge heights, if record is good.

Automatic register is equivalent to person staying or being at station all the time and recording different gauge heights as indicated on gauge at each period during the day. This is the
3792 kind of instrument I referred to but perhaps did not describe, on the Poudre. They were self recording instruments that maintained a constant record, but as they had 8 day clockworks, clock had to be re-wound and papers taken off once a week.

Made observations and measurements on Big Laramie River in 1912. They consisted of measurements of Big Laramie River and Little Laramie River also, but not these streams and all their tributaries. I started out to measure the tributaries and purpose was carried out as far as I could with time and means at disposal. I had from one to three men there during first part of 1912, that is up until after high water had passed, until some time in July. I was there myself quite a number of times and we established stations, especially on side streams. There were some records being taken on main stream, and at first I did not expect to duplicate these in any way, that is, we found that automatic self-registering instrument was placed on Big Laramie at Boswell's. At first I did not intend to duplicate that, but after we found instrument was not recording correctly, I took more pains to read gauge and also took measurements.

Instrument at Boswell Station in 1912 was inaccurate. First times I was there, I simply learned there was an instrument, and, of course, assumed it was keeping a correct record. Sometime later I happened at Boswell's and man was changing the papers on the instrument. He had been living at Boswell's the year before. He was put in charge of station and at this time had moved somewhere else as Boswell Ranch had been turned over to some other party. He at that time called my attention to fact that the pen on the chart did not agree with the depth of the river as indicated on the gauge. Pen or chart should record same *as* depth as shown on gauge. For illustration, if depth of river is 3 feet, pen should so show on chart. Pen simply duplicates readings on gauge. In this instance, however, it did not and further, if river rose one foot pen should indicate then a rise of a foot and if river went down 6 inches pen should indicate that fact on chart. He called my attention to fact that instrument did not agree with the depth of stream as shown on gauge. I asked him if he did not note on paper every time he took off, any change or irregularity. In continuity of season there are various causes which may affect movement of pen of instrument and when you put on a new chart or take off old one, pen may not be at quite exact elevation gauge rod shows. Now, I learned from him first of his experience. Observers are usually instructed to record on chart or paper the reading of the gauge rod at the beginning and end of the paper. That then gives a means in the office of verifying it and seeing if it is correct and eliminating any of these changes.

Observers, hydrographers and others having charge of stations should check gauge rod on stream with pen as indicated on chart

from time to time as they happen to pass. In this case, it was not being done and I asked him if he had not been doing that and he said "No" and after I suggested to him it was wise to put pen
3794 up to where it should be he said that he had no instructions to that effect. I told him it was desirable to do so and I should think he should have such instructions. That I would do so and take responsibility for it, which I did, and so marked the fact on the chart. Later on in season I think he was instructed and did make corresponding readings whenever he took chart off and put on new one.

That very night stream at Boswell's rose .4 of one foot. I saw that myself. I staved at Boswell's all night and in morning river had risen .4 of a foot over night. I had not had opportunity to compare the charts until recently, but in comparing movement of pen with fluctuations of river, I found that the pen on that night did not record any rise, in other words, the instrument was not keeping a record for some reason and there were several other occasions throughout season, showing that instrument was not a reliable instrument for some reason or other.

In comparing back with records as shown by instrument at Boswell's Station and observing gauge heights, which we had, there was an evident tendency for the pen on the instrument to drop down. It was shown in that particular night of which I speak and the next time I saw chart after that, which was the only other time subsequent that I saw it during the season, a couple of weeks later, I think the pen was .3 or .4 lower than the gauge showed it should be. It had failed to move in this other instance I speak of, that very night after pen was moved up one foot to correspond with river reading and had failed to record. Fact it did not rise with river I didn't know until I saw chart later here in office of State Engineer. I did not know that fact the next morning because I did not have access to the instrument. It was locked and man in charge lived over on Johnson Creek so, while I went over on Johnson Creek next day, I didn't see instrument or how it was recording and could not do so unless it happened I was at Boswell's at the same time that he was there.

3795 I made quite a number of ratings at Boswell Station in 1912 after we found the pen on the automatic register was not working properly. We took more pains to read the gauge as we went along and I instructed the observers who were there for me, spending their whole time on the river, to read the rod every time they went by and that was generally done.

This instrument was not of the type that I have been using and from my observation of its work there and comparison of it it does not seem to have given very good results.

May 29, 1912 was date Mr. Oviatt called my attention to fact that this instrument was not working properly. Later on upon seeing records in State Engineer's office, I also found a notation I think on sheet of May 12, by an employee of the State Engineer's office. He states on that that record was not working properly and was recording too low by about one foot. This seemed to have been case

for some time and that whole week was wrong. It was on May 29, that I observed it and moved the pen so as to make it correspond with the actual height as indicated on gauge.

After ascertaining that the instrument at Boswell's was not working correctly, I had my assistants keep gauge readings from time to time whenever opportunity offered and after seeing record, I also became rather suspicious of its general accuracy, because it does not show fluctuations in stream that are peculiar to these mountain streams and certainly so on the Poudre, which has daily fluctuations in times of high water.

3797 The charts show that the instrument recorded about a constant height. From my general knowledge of streams I began to doubt its sensitiveness, so that these were addition- reasons why I began to keep records there as I did elsewhere. These daily tides, as one might call them on these snow fed streams, are not evident on Laramie River according to this sheet.

I have checked those charts taken from this automatic register maintained at Boswell's in 1912. This checking has been done since 1912. I have checked them with the gauge readings which I obtained. Wherever the instrument was found not recording properly, I think it was invariably found to be recording lower than the actual height. We can note several cases. Thus on May 29 pen was recording 2 feet and gauge rod recorded 3 feet in depth. Pen was then reset at what was intended to be 3 feet but actually was about 2.95 feet. Next morning gauge rod actually read 3.45 feet in depth at 6:30 o'clock a. m. and record made by pen on chart of instrument indicates that it was recording 3.05 feet. In other words, while stream itself rose .4 during night, pen raised .1. I might mention that is rather difficult to read this small amount with any degree of accuracy on chart because mark made by pen is fully equivalent to .1 on the sheet. These measurements were all in feet.

On June 1, there is a notation made on paper, I think by myself, that the rod was reading 3.3 while pen on chart at same time indicated depth of 3 feet. The pen and the gauge did not agree but the difference was not so great as it was on May 29, and, as it was difficult to set pen, and as I didn't want to interfere for relatively small differences, I did not attempt to set pen, simply indicated discrepancy. June 4 river was gauged and average height during gauging was 3.62 feet in depth. Rise varied during gauging from 3.60 to 3.65. Reading of pen as recorded on chart is between .3 and .4 feet low at that time. On June 11 we have notation and was first chance after that we had to compare. On that date we made gauging early in the morning at which time reading of gauge rod was 3.5, pen was recording on chart 3.2, so it was below actual height. The pen I believe was moved up to 3.5 which corresponds with actual depth, but I do not recall whether we made change or not, I do not think we did.

I think it was about that time that I had mentioned to observer, Mr. Oviatt, that when he took off paper he ought to indicate on sheet the reading on gauge rod, so that at office of State Engineer they might see if any correction were needed.

June 20, we found reading seemed to be very nearly same as pen

I believe, gauge height at 7 o'clock a. m. was 2.6. July 2 we made a reading early in the morning. Gauge height was 3.10 feet. Pen on chart read 3 feet and was apparently slightly low. From that time we had no checks, but there were several checks later on by representative of State Engineer's office, at times when depths were much less. There was one on July 17, one on August 16 and on September 26. At time of these readings quantity of water in stream was less than ½ of what it was in cases where we had opportunity to check. I think that at time of making this reading in July was last time anyone from my office was at Boswell's during
3798 1912.

Laramie River at Boswell's goes under a bridge. Stream is at extreme east side of bottoms and bends just a little above the river bridge, flowing from west side of bottom abruptly east, almost at right angles, and then turns north almost at right angles, just a little above bridge. Road which crosses bridge passes across bottoms for approximately quarter of a mile where it strikes west side. River does not run quite north and south, but approximately so, so it may be called that direction, and hence river runs approximately parallel to road for distance of 600 to 800 feet before it turns at right angles and flows under bridge near Boswell house. Bottoms west of house and along road are about uniform height as you cross bottoms west of bridge and west of channel proper and they partake of general slope of valley going down stream, so it is matter of fact that point where river bends is higher than ground at road. I refer to place where river bends upstream and above the road and the bridge, where it changes from direction nearly north to direction nearly east. If river overflows bank, water would simply pass down valley to road.

Banks of stream are relatively low. From my observations on night of May 29 and on May 30, 1912, I should judge river *brings* to overflow and run over bank at about 3.4 feet in depth as recorded on gauge height at bridge. This overflow water that comes out of river runs over meadows and is carried across road by several culverts to west of bridge. There is one immediately west of bridge about 100 feet, a second culvert at a little greater distance and another culvert at something like 800 feet west of river bridge.
3799 As I recall the west culvert is about 18 feet long. These distances were not measured and are simply estimates. They are approximately correct.

Road is a low embankment slightly above level of meadow and these culverts then carry water that overflows from river.

Water in river raised from 3 to 3.4 feet in depth at bridge one night when I was staying at Boswell's. Men were working with scrapers in evening on road, filling up some of low places on road, so water would not run over it. Conditions were indicating that water was going to come down to road and they were working there with scrapers. They left scrapers when they unhitched that night, on south side of road, that is, on upstream side. In the morning the scraper was very nearly submerged with water. River had only

risen .4 in depth as recorded on gauge, but as it was backed up by road it had risen on road several feet.

May 31, in morning, water was going through first culvert west of bridge, just beginning to go through, not very large flow. Whether it went through other culverts, I did not observe at that time. I had not, previous to this time, been over to Johnson Creek and did not know of these other two culverts, that is, a culvert and a bridge, so I did not see the other two on that date, but from facts as I later found them, as I actually observed them, I think water must have been passing through those other two culverts on that morn-
3800 ing. I think water rather tends to pass through the westerly of these three culverts first, owing to topography of valley. There was a little depression there, possibly an old river channel, and this west culvert is the larger of the three, it is 18 feet long instead of 8 feet, so it might be considered to have the dignity of a bridge. Of the other two culverts one is 8 feet wide and the other is 6½ feet wide.

I think water must have gone through west culvert at least, and probably through both of west ones on morning of May 31, 1912. If it was, I did not measure it on that date. I did not suspect it until I saw these culverts later on and as water went down. Later on, at a less gauge height, we found water going through these other culverts. I presume it must have been going on May 31 also. These culverts were quite deep, that is, water was on June 11. Gauge reading indicated 3½ feet deep on that day and in first culvert nearest bridge water was 3.3 feet deep. It was passing through culvert at that depth and flowing quite rapidly. In first culvert it had velocity of about 1½ feet per second. In second culvert, which was 6½ feet wide but relatively shallow, greatest depth was 2.1 feet and at last culvert, which is 18 feet wide or with a bridge of that length, water depth ran up to 4.5 and was over 4 feet deep for quite a portion of its width, so that, all things considered, I think that west culvert must have been carrying water even at the low overflow stages. Velocity at west culvert went up as high as 3.3 feet per second and average velocity for whole cross section of that culvert was nearly 3 feet per second on June 11, after stream had gone down quite a little bit.

3801 It was evident from conditions as we found them that, after stream reaches a certain gauge height, there is quite an appreciable amount of water going around the bridge and is not included in the stream channel proper. June 4, there was practically 500 cubic feet per second going through these three culverts as compared with 2012 feet under bridge. On June 11 there was 220 cubic feet per second going through these three culverts as compared with 1790 cubic feet per second going under bridge proper, so that it was evident from conditions that discharges of Laramie River at Boswell's Station should take these culverts into account when river began to overflow. At Boswell's Station at 3.4 feet gauge height, and I think it must be lower, overflow occurs and culverts should be taken into account.

Water continued to run around the station at the Boswell Bridge,

over the bottoms and through these outside culverts more than four weeks, a month of heavy run-off during summer of 1912.

Water first commenced to go around Bridge at Boswell Station and through first culvert, the shallow one, night of May 29-30, 1912. Did not observe the deep culvert on that date and so from observation could not state whether water was then going through it, but think it must have been doing so.

Could not state when water ceases to overflow bottom above bridge and ceases to pass under these culverts, owing to lack of continuous observations of the culverts. June 20, there was a measurement made of river at Boswell's bridge and no record is made of water going through these culverts, so that I presume it had stopped
3802 there at that time. On night of May 29 and 30, when I first saw it overflowing near bridge, in evening of May 29 at gauge depth of 3 feet water was not going through culvert but overflow was imminent. Next morning at gauge height 3.4 water was flowing over meadows and through culvert in quite a stream, so that it must have began to overflow river banks and to pass through first culvert between gauge heights of 3 feet and 3.4 feet at the west culvert, the furthest from the river, the river bottom was lower and would catch water just as soon as it ran over bank above. From situation, it might have protected it somewhat and just when it would begin to overflow the bank and go down over meadow I cannot say. After it started to run over though, I think it would keep up a little longer and at a little less gauge height than when it started. After water gets over the lip of the channel, as it were, it is apt to make some little channels and to continue.

A large quantity of water of Laramie River in 1912, escaped from channel and ran through these culverts by overflowing around and away from gauging station. On June 4 we measured the water and found 500 cubic feet per second passing around the main station. 500 cubic feet per second would be equivalent to 1000 acre feet per day.

Have platted results of my various gaugings at Boswell Station during 1912. I have brought together dates, gauge heights and discharges as we measured them that year at that station. Memorandum of these facts reads as follows:—May 31 from 1:45 to 3 P. M., gauge heights 3.40, area cross section 247.15 square feet, mean velocity 7.28 feet per second. Discharge 1807.18 cubic feet per second (see 3804).

June 4 from 7 to 9 o'clock A. M., gauge height 3.62, cross section 279½ square feet, velocity 7.23 feet per second. Discharge 2511.7 cubic feet per second, this included normal;

June 11, 9 A. M., gauge height 3.5 feet, cross section 255.72
3803 square feet, velocity 7 feet per second; Discharge 2010.9 cubic feet per second;

June 20, from 7 to 8 A. M., gauge height 2.6 feet, cross section 187.80 square feet, velocity 4.18 feet per second. Discharge 784.86 cubic feet per second;

June 25, from 7 to 8 o'clock A. M., gauge height 3.25 feet, cross

section 342.41 square feet, velocity 6.04 feet per second. Discharge 1553.6 cubic feet per second;

July 2 from 7:30 to 8:40, gauge height 3 feet, cross section 322.34 square feet, velocity 5.56 feet per second. Discharge 1237.65 cubic feet per second;

River continues to overflow and water to pass through westerly most culvert until river falls below 3.25 gauge height at bridge. I slighted one of these measurements a few minutes since, in answer to question as to when river stopped overflowing bank. Our measurement at gauge height 3.25 feet shows a flow through westeriy-most culvert. At that gauge height on main bridge, the gauge which we fixed on this westerly culvert shows one foot of water in depth passing through it and also showed that quantity was 29 cubic feet per second there passing.

Areas which I have given for June 4 and June 11, are areas of portion of stream under bridge only and exclude culverts. Area of culverts is excluded from consideration in these two measurements. Velocities are for the main stream only.

3804 Measurement of May 31, giving total of 1807.18 cubic feet per second discharge was made on rise of river. I do not include western culvert, which I have no doubt did discharge a considerable at that time. I estimated the amount passing under first culvert was 7 cubic feet per second, I did not measure it, it was a small amount and would not be material one way or the other. 1807.18 cubic feet per second is too low for the actual amount probably passing at that time. It is too low by considerable. June 25 with gauge height at 3.25 we have 29 cubic feet per second passing through western culvert. June 11 with gauge height of 3.50 we have 179 cubic feet going through western culvert, so that for intermediate depth of 3.4 feet on gauge height on gauge, which was case on May 31, quantity passing underneath we-terly culvert was somewhere between those two extremes and probably something like 10 cubic feet per second.

3805 We used vertical intergration method in ascertaining velocities of current at Boswell Station in ratings made in 1912, that is, determined velocity in vertical lines and these vertical lines were half way between stations, that is, places where we took depths. Depths were determined in that case with an iron rod measuring down from surface of bridge to bottom of stream and from bridge down to water. It was rather difficult because of fluctuation of stream and rapidity of flow. Water was fluctuating more or less and to get mean height, extremes of fluctuation of water were obtained and mean of these two were taken as height of water surface.

An electric meter of Price pattern which recorded every fifth revolution was used.

Speaking in common parlance, it was instrument that clicked every fifth revolution of meter wheel. Operator at a telephone by which clicks were indicated. This was fastened by a headpiece over his ear and then, by aid of a stopwatch, clicks were counted. Stopwatch was started at the click and was stopped after a certain number of clicks, in this case generally twenty clicks or one hundred revolu-

tions, which would correspond to about 230 feet of current having passed.

Made no measurements at Boswell Station in 1911. There were same kind of automatic registers, I believe, kept there during that year and same man took paper off, that I met there in 1912, Mr. Oviatt. He was then living at Boswell Ranch house right adjacent to station.

3805 It is very possible that some of water flowing in Laramie River in 1911, overflowed bank. I think it is probable even under discharge as published, but with same automatic register and same method and same lack of recording at time paper was taken off or on just what gauge height was shown by gauge rod, it is quite possible and in fact probable, that records of machine were defective in 1911, just as we found them in 1912. They evidently registered less water than was actually passing. I have not made a comparison of the times they were measured, but Mr. Oviatt who had changed the papers in 1911 also, I believe had not been accustomed to marking sheets so there would be any change from that source at time that would enable one to correct these sheets. But if record be correct, as far as that is concerned, which is subject to a very grave question, there would also be the fact that water would go through westerlymost culvert for a while at least, so that would not be shown by diagram, and if pen was out at all, or subject to same errors as in 1912, the period of time would be much longer than the sheet would otherwise show for that year.

Have observed record of flow at Boswell Station for 1912 as published in report of Charles W. Comstock, former State Engineer of Colorado. From examination of this published statement as to flow, compared with facts as ascertained from actual observations on ground, I find in first place, record of machine from which these published records was obtained was wrong, during period of high water as I have shown by comparing with observation made by myself and assistants. These inaccuracies were to some extent taken into consideration by hydrographer before making up final

3807 records during that period from May 11 to June 16, assistants under direction of Mr. Comstock made no measurements at all, and that was period of high water, nor did they make any measurements from June 16 to July 18 and there again was a period of high water.

General history of river was a rise about May 15 up to a summit of flow June 5, then a cold spell which caused it to drop down quite low June 20, then a high stream came again June 27 and 28 and then again a drop. As it happened, measurements that were made under Mr. Comstock's direction, skipped these high peaks, both of them, from May 11 to June 17 and from June 16 to July 18 and they did not have any measurements of high water, that enabled them to form a rating curve wherein there was a measurement of high water. A rating curve as I previously stated, is dependable for heights between ascertained heights. It is dependable between the higher and the lower ascertained heights, but it has got to use another term. A curve of that kind is good for interpolation but not for ex-

terpolation. That is, it is good to fill in between known points, but is rather unworthy to extend beyond ascertained facts. If your highest measurement has been 3 feet in depth, for example, it is quite dangerous and at least uncertain, to deduce what discharge would be at a gauge depth of four feet. If, on other hand, you had had measurement at five feet in depth and another at 3 feet in depth, then determination of flow at 4 feet in depth would be quite sufficient. Now they did not have any high water measurements at all or any data for their rating curve for those heights at that time. Highest measurement for 1911 was for less than 1100 cubic feet per second and in 1912 was only 840 cubic feet per second, so that when water doubled that or more, tripled it in fact, why, their curve might be off to considerable degree, that is always found to be the case.

3808 This is largely true where water is not confined to same channel but overflows above station and goes off in different channels and in this particular case, quite a good deal of water went by in channels that would not be observed at all in low water, in channels that would not be seen. I, myself, missed and did not observe an important channel and it was only by accident that I found it had been running water. I had not gone to it and did not suspect it. I had had no cause to go that way. My attention was drawn to it afterwards because I had occasion to go that way in going to Johnson Creek. If I had not been going to Johnson Creek I could not say that I would have known of that channel at this time and certainly not unless somebody had mentioned it to me.

The State Engineer's records, as far as rating curve was concerned, was based on their own records and did not go far enough to take in high water. They did not have direct measurements anywhere during high water. Consequently measurements made by me or under my direction, came in just during the time of the peak flow. This was fortunate. The State Engineer's office in working up records of the automatic instrument, attempted to correct for these changes the pen had made, I believe. Of course some changes might take place and it would be very difficult to determine just what they had been or just what to eliminate, but rating curve they used as compiled from their previous measurements had been for flow of river under bridge. It did not include water that had passed through culverts and the third bridge to the west.

3809 Consequently when they extended their rating curve, or attempted to deduce amount of water that would be flowing at given height, they would infer an amount of water from that curve, which would give them an amount of water passing under bridge and excluding portion that went through other culverts. While their correction for error in position of pen seems to have been fairly well done, their rating curve seems to have been based upon flow under bridge and it is not surprising that they left out of account all flow under other culverts, and that would account for amount I give and deductions of their curves.

It is also fact that at some point before the high part is reached, the channel even under the bridge suddenly broadens. At a

moderate height, about 3 feet, river is confined to practically two spans of bridge, while when it gets to 3½ feet it flows under 3 spans. In plotting a theoretical curve, this extra width is not taken directly into consideration, but as matter of fact curve does take it into consideration if they have sufficient observations. If they do not have observations at greater depths, they would be apt to leave that out of account, because curve is drawn on approximately same law for extra heights as for observed heights, and that means it was drawn on supposition of continuance of same conditions, and that would be practically for same channel. In that case it would fall short where river suddenly broadens. In this case, cross sec-
3810 tion very suddenly increases, very materially increases at a depth approximate- 3 feet. It is, as I remember it, about 40 feet wide. These spans are approximately 20 feet long, possibly a little less, then up to 3 feet in depth it flows in space of 40 feet, then upon becoming a little deeper, it becomes 60 feet wide. Am familiar with Woods Landing Station on Laramie River. Visited it a number of times. Road going up river crosses bridge at that point so that gauging rod which was on bridge and conditions there were observable every time.

Familiar with Glendevey rating Station. It is fairly good. Probably as good as most of those mountain stations. Did not see self-recorder they had there in 1912. Think man who took off paper did not live near bridge, it was about one mile away. Forest Ranger attended to it and he never happened to be there when I was at Glendevey Station, so that I never had opportunity to see instrument and compare pen with actual gauge height. After I saw errors in machine at Boswell, which I did not appreciate until along in June, I was rather desirous of seeing that one at Glendevey and observing whether it was recording properly, but I did not have opportunity.

I established a number of gauging stations in 1912 on various tributaries of Laramie River entering stream on both sides above Woods Landing and more than that, I intended to establish them on all tributary streams and this was practically done, although we did not completely carry out our intention. We had measurements on following tributaries of Laramie River:

Grace, Bear, Johnson, Jimmy, Forester, Fox, Beaver, Woods, Stub, Nunn, Deadman, Rawah, McIntyre near mouth, Lagarde on two stations, Laramie at Glendevey, Stuck and other creeks including west branch of Laramie and Lake Hattie Inlet on both Big and Little Laramie Rivers. Besides that there were occasional measurements made on other streams as opportunity permitted.

Regular observations were made on those streams mentioned, that is, as often as observer could be there. On some of them such as McIntyre, Johnson, Beaver and Lagarde Creeks, we had intermittent observations made by persons living in vicinity. At Glendevey and Boswell's, which were counted of considerable importance, we had supposed in beginning that record could be depended upon for those readings and did not attempt to duplicate them until we found they were uncertain, I mean at Glendevey and Boswell's. I do not

know whether Station at Glendevey was working properly. Have not had chance to compare gauge heights with the instrument, but we did take gauge heights at a number of times and that would give means of checking it up.

3812 In establishing all stations on tributaries of Laramie, best possible location was selected, that is, one where water could be confined to one channel and one where bottom was stable, and, if possible free from large stones and also one that was accessible. That was quite important. First time in looking around it was attempted to find place where some person could be found to act as observer. That we found was not possible except on McIntyre, Lagarde, Johnson and Beaver Creeks, although those were not very satisfactory. So, in each of these cases, there were two things to be done as in case with main river, first to select a place that was fairly suitable to establish a reference point, so all ratings that should be made thereafter could be referred to same data and then to take enough of these measurements at different stages of stream to make a rating curve. Then having a rating curve, if we had height of water on intermediate days on same date we could determine what amount of water then flowing was with relative certainty. That was general condition. Most of them were fairly accessible. Stations were fairly good, as good as conditions would permit, streams were crooked in many cases and in many places an ideal station could not be found but one that would be fairly good under conditions.

State Engineer John E. Field, had access to sheets on which depths and measurements made in 1912 were recorded and I know he and his men took notes from my memoranda. To what extent they took notes I do not know but think they took whole series of measurements.

3813 I have had no opportunity of checking with Mr. Field relative to his use of those notes but I do know in one sheet he has prepared of measurements, that he has noted use of all measurements I made in 1912 for purpose of obtaining rating curves, so that he certainly made use of those. As to gauge heights on McIntyre for instance, and so on, I cannot say. I never heard him say and never asked about those. I think those sheets were put in hands of assistants. He was looking them over and I think he took those records and thus they were used, I suppose.

Principal tributary streams entering Laramie River between Woods Landing and Glendevey Stations are McIntyre and Lagarde Creeks between state line and Glendevey. Stuck is very good stream but not as large as these. Grace Creek is a pretty good creek. Of course there are a number of streams that bring down considerable water. Grace Creek for instance has watershed of about 13 square miles, Jimmy Creek has watershed of about 20 square miles. Stub Creek at times runs as high as 45 cubic feet per second and that was not at extreme high water. Johnson and Beaver are

3814 principal creeks entering from west below state line. Above Glendevey Station Nunn creek comes in just above station and Rawah also comes in above Glendevey Station.

McIntyre and Lagarde together are two very excellent creeks and

yield most water of all tributaries. The latter creek is in no way diverted by Greeley-Poudre System. That system intercepts headwaters of Mill Creek below McIntyre. It does not take very much of the McIntyre even.

McIntyre Creek has drainage area of about 41 square miles and Lagarde of about 27 square miles. Maximum discharge shown by our observations, for Lagarde Creek during 1912 was 485 cubic feet per second.

Highest single measurement made by us on Grace Creek is 120 cubic feet per second. That was at secondary maximum, that is, it was apparantly after maximum flow had passed and after stream had dropped down same as main river had at Boswell's which I mentioned some time since, but was at about secondary maximum. By comparison I think there is no doubt of fact that there were indications of larger flow having already passed at time rating was made. Indications of the streams rising and falling are quite parallel, so where one stream goes up and has a maximum, adjacent streams will also have maximums at about same time, or within a day or two. If a period of cold weather or cloudy weather comes on, streams will drop, but that is a general condition and all streams go down about the same time and rise about same time, so we have those periods of maximum flow of water. In 1912
3815 there were two very marked peaks of flow on all those streams. Those peaks correspond quite closely with those described by me in connection with Boswell records.

Johnson Creek in 1912 showed maximum measurement of about 150 cubic feet per second.

Beaver Creek, highest single measurement 1912 was 93 cubic feet per second, and there were number of measurements very near at that point. Beaver Creek might be said to have gone practically 100 cubic feet per second.

Various measurements were made from time to time during progress of season. Intention was to make systematic measurements on all streams as conditions permitted. We visited not only upper Laramie River but also visited other stations down below and on Little Laramie River.

Stuck Creek, 1912, highest measurement was about 100 cubic feet per second, this was taken at apparently secondary maximum flow. If measurement had been taken at primary or first maximum, as compared with secondary primary maximum at Boswell, it probably would have reached considerably higher amount. It would take little further comparison to translate what primary maximum was and expressed in figures, because of fact that water-shed is smaller and at lower elevation and it
would depend somewhat on character of water at that time,
3816 whether melting of snow was at low or high elevation. If melting snow was at low elevation and perhaps was, streams would be larger in proportion that they would be later, because in later periods a larger percent would be coming from streams at higher altitudes.

On Little Laramie River we made measurements on inlets to

Lake Hattie, on inlet to Lake James at times, on stream itself at Wrights, that is at Lake James inlet, also on Little Laramie at mouth at Two Rivers where it flows into principal stream.

Medicine Bow Range of mountains forms west boundary of Laramie watershed. It forms west boundary of Big Laramie principally in Colorado and west boundary of Little Laramie watershed in Wyoming. Character of this watershed was also investigated in secondary way by observations carried on from time to time as to amount of snow that was collected there. These investigations were during spring and winter months.

From these observations, I found that Medicine Bow Range is very excellent source of water supply. A very much better source than I had anticipated at the beginning. Summit of a portion of this ridge at headwaters of Little Laramie is somewhat lower than it is further up in Colorado. It rises in Medicine Bow Peak in Wyoming, to height of 12,000 feet, or thereabouts, some distance above timber line. Snow on this range becomes very deep. There is a great deal of snow. Run-off from it is relatively large, so it is really a very excellent contributor of water and really about as good as almost any part of range in north, except extreme high portions.

In checking water supply conditions, I used not only stream measurements which we had but supplemented them by various trips over this mountain range. Observations of precipitation are unsatisfactory unless they can be carried on for some time. Snow records, however, form a means of getting at amount of precipitation which falls in winter, because snow lies on ground, and until snow begins to melt it is practically the sum of all that has fallen during winter months. Consequently in absence of rain-fall records, snow records is a means quite satisfactory in getting at amount of available precipitation and water. The principal difficulty in obtaining these snow records is that there are no people in those regions to make observations and no people there who can be used as a base for supplies.

In order to obtain these snow records I sent parties on snow shoes and in a number of cases with blankets, who lived on the country and what they could carry on their backs and made measurements not only of snow, but of amount of water there was in snow. All of these investigations demonstrate fact that watershed is a very excellent one. This was shown both by quantity of water, its run-off as compared with its area, and by depth of snow and amount of water it contained.

3818 Mountain range does not run to a sharp peak but is rather a broad one, a broad ridge, and so much of it is at a high elevation that gives an excellent shed, more so than if it came to a sharp ridge.

As a whole, Medicine Bow Range is certainly not inferior from standpoint of water supply. Supply as a whole, as compared with this area, is very good indeed. Run-off is relatively large and the supply of water good.

3818 LOUIS G. CARPENTER.

Examination by Mr. Fred Farrar:

At upper reaches Laramie River in vicinity of Chambers Lake there is, generally speaking, a divergent range which forms eastern divide of Laramie River watershed, separating it from Poudre watershed. This range is sometimes spoken of as Laramie Range and in this testimony is termed the Green Mountains. This range is lower and much poorer from standpoint of water supply than is Medicine Bow Range. In Green Mountains there are no peaks that go above timber line. Chambers Lake is about 11,000 feet in altitude and that indicates in general way fact that it does not go as high. In Medicine Bow Range there are several groups of peaks that go above timber line.

Cameron Pass crosses main range of mountains in vicinity of Chambers Lake.

Ute Pass is situated generally west of Glendevey at point where state road crosses range. The Pass west of Boswell's is sometimes called Ute Pass also. This latter is approximately on interstate line.

Going northerly from interstate line, mountains rise reaching climax at Medicine Bow or Centennial Peak in Wyoming. Range in Wyoming is much broader than in Colorado. In this group of mountains adjacent to Medicine Bow Peak, right west of town of Centennial, group of streams contributing and forming Little Laramie have their origin. There is group of various peaks in there.

3820 Difficulties in obtaining snow observations were first physical difficulties of going into region of steep mountain slopes and region where there are no settlers. A region where it is necessary to go on snow shoes; where it is necessary for person to carry all his supplies. Taking it together, it means journey with good deal of hardship and calls for person not only skillful in handling snowshoes but also person of nerve and daring, to greater or less extent. It calls for person of self-reliance who is willing to take risks for, under these conditions where a person goes away from places of habitation and on a path it would be almost impossible to follow in case of any serious accident, such as breaking a leg in going through fallen timber which is plentiful, it would be almost impossible for observer to escape death before he could be rescued. In fact, no one would know that accident had befallen the observer until it was too late to be of any service to him. Really the first great difficulty is in finding a man to do this work. I might mention that in one trip a man who went out for me, Mr. A. P. Morey, carried a load of 50 pounds on his back in clim-ing those sharp mountain slopes. He was out some days. These observations took him generally the whole extent of the Medicine Bow Range from Medicine Bow Peak to the vicinity of Chambers Lake.

3821 More attention was given to conditions down in Wyoming. That was partly intention but a number of trips were made in vicinity of Clark's peak which is at South end of this Medicine Bow Range right opposite the headwaters of Laramie River. A trip was made all along the range including the range from Clarks Peak to Wyoming State line. Trips were made in Wyoming

along summit of ridge quite a number of times and two trips were made to top of Medicine Bow Peak. It would be almost impossible to make continuous trip along whole length of mountain range without coming down to valley for supplies. Difficulty in going from Clark's Peak to state line was fact that there was no stopping place or cabin or means of getting there for one thing, and then again, we expected that that work would be done by another party which we failed to reach successfully. This accounts for fact that greater observations were made in Wyoming portion of the Medicine Bow Range rather than in Colorado and for the addition- reason that we could reach summit of ridge in one place by means of the Laramie and Hahn's Peak Railroad.

Snow observer worked from point several miles south of Glendevey at Stuart's Cabin which was last inhabited spot near mouth of west branch of Laramie River. Observations were made in March, April, May and June of 1912 and in May and June of 1913. Also had observations of similar character taken of Medicine Bow Range in Colorado at time previous to that. This was some years
3822 ago at which time I sent Mr. Decker up there. He went for me several springs and I had also had before that, records made at extreme south end of Medicine Bow Range when Mr. Enos A. Mills made trips for same purpose for me.

In determining amount of water contained in snow on Medicine Bow Range used two principal methods. First was to actually melt snow, measure depth of snow then melted and determine amount of water it held. That was found difficult to apply in practice, because observers were away from any place to stop and it took considerable time. This finally resulted in the second way which I adopted, of determining amount of water content by weight. Taking a section of snow of definite size and then weighing it. That would be same as weight of melted snow or water and then comparing depth of snow with depth of water found by weight. When I first sent out Mr. Mills we used an aluminum tube but this was not very successful and I finally used the other method.

Conclusions drawn from observations relative to water supply from the Medicine Bow Range in its different sections are indicated by reading a few measurements. For instance, at one station, April 30, 1912, there were 24 inches of snow which contained about 30% water. That was on Medicine Bow Range not far from interstate line but in Wyoming. That was at one of comparatively low places on the range.

Snow in its ordinary condition, fairly well packed, would contain about 10% water, so this 29% of water, three times the average, would represent normal fall of 150 inches or 12 feet of snow before it was settled or consolidated. This observation as I stated
3823 was taken April 30, 1912. Evidently portions of it had melted before that time which explains greater density. Density indicates that water had descended and soaked up rest of snow something like a sponge, and had remained in the snow. This water was not set free until later in Spring. That fact is substantially shown by measurements later in season. Run-off at lower elevations

begins earlier than that, but not very much. Run-off depends on character of spring. There is very little run-off for elevations as great as these that early. There is considerable run-off at lower elevations, say 7000 feet, prior to this time. Where snow is as deep as that, water is held in the snow.

Two hundred or more observations of depths of snow at different places were made altogether. In 30 or 40 of these the quantity of water in the snow was determined. I can give data indicating results of these observations in that portion of the range ordinarily designated the Centennial mountains at head of Little Laramie.

I furnished printed forms for observer in which were recorded location, elevation taken by barometer, and depth of snow at number of different places, aspect, character of timber and other conditions that affect snow. The density of snow and whether or not it was crusted, granulated or otherwise and other facts were also observed and noted. Measurements of snow depths were taken frequently while measurements of quantity of water were taken at less frequent intervals. Those were not so necessary.

3824 Have not had opportunity to check Mr. Field's conclusions as to flow of water in Laramie River, as given in his testimony, except to this extent, I have compared his heights at Boswell Station with my rating curves and was either informed of or heard part of his testimony showing how he derived his conclusions. I will prepare to testify as far as possible concerning this matter in the morning.

Referring to Poudre River, report of State Engineer for Colorado for biennial period 1912, shows that on November 1, 1912, there were 83,794 acre feet of water in storage of reservoirs in that water district. That amount of water in storage on that dates does not necessarily indicate surplus of water during preceeding irrigation seasons.

Storage of water in Cache la Poudre River begins at close of irrigation season. In favorable years they begin a little earlier. In some years there is surplus water in September, ordinarily

3825 they cannot begin storage until October or November. In 1911 litigation was commenced by appropriators of water down in South Platte district in vicinity of Fort Morgan, preventing storage of water to great extent in valley after irrigation season was closed. State Engineer's report shows that in year 1911 about 17,000 acre feet of water were in storage in the Poudre Valley reservoirs on November 1. Presence of that water in those reservoirs on that date would not indicate surplus of water for use of irrigation during preceeding season.

People in Poudre Valley, as mentioned in my direct testimony some weeks since, use every drop of water they can and if, at times during irrigation season, there is water that either because of size of stream or because of storms is available but cannot be used directly, they store it. They utilize all water that comes. This use is simply result of that general need of water which is felt in Valley and a matter of not letting any water run to waste.

146,000 acre feet reservoir storage capacity as heretofore given

for reservoirs in water district No. 3 Colorado, does by no means indicate total needs of valley for water for irrigation of its crops. Long before reservoirs were constructed, there were the ditches and reservoirs were built to supplement ditches and not as independent sources of supply. These reservoirs have been constructed as adjuncts to the ditches and the building of reservoirs has not decreased use of ditches at all, on the contrary, it has assisted in developing a much larger area of land and the reservoir supply of water is used
to insure water for crops over a large area which is already
3826 partially supplied by water from ditches. Reservoirs as a
whole are looked upon as only a partial supply and in amount much less than supply from streams direct.

It would be economically impossible and unwise and unjustified to construct a system of ditches and reservoirs of sufficient size and capacity to intercept and store all of water of stream such as Poudre River, at its extraordinary high stages. This could not be done from financial conditions. These extraordinary flows are of course only once in a series of years and that would mean then that in 9 years out of 10, for instance, or 4 out of 5, or 19 out of 20, whatever it might be, the series of works that were built large enough to take these extraordinary floods would be more or less deficient in supply and therefore the capital which had been invested in such works would be more or less unproductive. That is one reason from a purely financial condition. The second reason, which is more important in the development, is the related fact that if people took up lands which were to be supplied by such flood waters, they would be short for a considerable part of the time and thus those people would be at least hampered in their attempt to make a living and perhaps prevented from so doing by lack of water. This would lead to failure so that when an extraordinary year
occurred, settlement would be more or less gone. People
3827 have to live steadily and not simply once in a while.

It would not be physically possible to construct a ditch which would enable diversion of the enormous quantity of water passing down the river during a few hours in extraordinary high water in ordinary years, which excess water now passes out of district. The general rule and conditions for such a condition would be same as that of attempting to utilize extraordinary flows only once in a few years. It is not only possible but usually true on the streams that there are times of flow of water beyond the ability of ditch of reasonably capacity to carry. Mere fact that water of that nature passes from Poudre River into Platte, does not indicate a loss to industrial factors in Colorado.

Water which goes out of Poudre River may be used down on South Platte River. There are ditches on South Platte River of earlier date than many ditches on Poudre River and so far as water which passes out of Poudre River is concerned, it may be taken in by those lower ditches and usually is.

Poudre River territory has used its facilities for storing water to a remarkable degree. It started in 80's with one or two reservoirs and of course used the best ones first, that is, generally speaking,

those that were available for ditches that most needed them. Gradually they have been taking over the more expensive reservoirs and have developed an extensive and very perfect system and practically all of reservoir capacity that has been available has been used.

3828 There is not sufficient water under known conditions on Poudre River, which would be by any reasonable means, intercepted and stored in sufficient quantity to irrigate lands in Greeley-Poudre Irrigation District. Considerably less than one half of the lands included in the Greeley-Poudre Irrigation District could obtain water supply from Cache la Poudre River on an average. This is my general conclusion without refreshing my memory from opinions previously drawn. This amount could not be obtained without erection of dams across Poudre River for proposed channel reservoirs which are designated on map "Exhibit No. 1," as Stove Prairie, Elkhorn and Roosevelt Reservoirs. It would require construction of such dams and my answer involved that supposition. My answer did not consider question whether it would be financially feasible to go to that extent of construction of those dams for that small area and, in fact, I doubt very much whether that would be so. Ditches could not be constructed which would carry water some distance from river so as to utilize any such flow and quantity that could then be utilized would require these expensive reservoirs across channel that could collect floods even if they held them back without requiring an inlet canal. These reservoirs would be very expensive.

Cost of Wheatland Reservoir No. 2, $140,000 for storage capacity of 126,000 acre feet, is no criterion for cost of construction of these channel reservoirs on Poudre River which are proposed as part of Greeley-Poudre System. There is no comparison in cost. Wheatland Reservoir has an earthen dam, very low, that is 30 or 40 feet and not any great length. There is a natural basin which this dam utilizes. In case of mountain channel like Poudre River, a high dam is called for. Expense increases very rapidly as height increases so that if you double height of dam you increase cost something like at least by square of height in a general way. Cost increases very rapidly and engineering difficulties increase likewise, so that character of construction which would suffice for dam 30 feet high would be totally inadequate for dam 100 or 200 feet high. General conditions of latter would call for masonry dam. These conditions require great cost and capacity is relatively very much less and cost compared with quantity of water stored is very much higher.

Cost of Wheatland Reservoir No. 2 is very much less than cost of storage generally in Poudre Valley. Dam on Wheatland Reservoir is less expensive than dams of many reservoirs in Poudre Valley, and, while Wheatland Reservoir is said to contain 126,000 acre feet of water, corresponding dams at corresponding

3830 cost in Poudre Valley might hold from 5000 to 7000 acre feet while cost of construction would be about same. That illustrates relatively difference in proportion of cost.

Reservoir dams in Poudre Valley have been rip rapped in various

ways, some of them with rock and some with concrete. Where they have not been far distant from mountains they have taken rock. This rock is piled irregularly forming surface against which waves break. In case of Cache la Poudre No. 2 Reservoir they brought rock from mountains by trains and then hauled it 2 or 3 miles from railroad station. It is sandstone from foothills. It is not shale. The surface of dam is paved with it laid irregularly. The cost is very much increased by necessity of paving.

Lake Hattie and Lake James Reservoirs in Wyoming are of large capacity and dams are not very expensive. Considering capacity general comparison as to cost between them and Poudre Reservoirs would be about same as that given for Wheatland Reservoir
3831 No. 2.

From standpoint of economy of construction conditions in Wyoming lend themselves largely in favor of reservoir construction in that area, as to cheapness of construction, largely because basins are very large.

3832 JOHN E. FIELD, recalled.

Direct examination by Mr. Fred Farrar:

In opening testimony in evidence for defense, I stated that drainage area of Big Laramie River at Boswell's Ranch is about 365 square miles, all in Colorado. This evidence appears at page 35 of transcript. Have since made closer computation of area included within this drainage and find it to be 312 square miles. My testimony in that regard should be corrected to read 312 square miles in lieu of 365 square miles.

3832 Cross-examination by Mr. N. E. Corthell:

Included in the waste water surface on the Laramie Plains which I have given is Carrol Lake, which is used partially for irrigation, and Alsop Lakes which may possibly be used in times of scarcity for irrigation purposes, but no really available use is made of either of these, although to a slight extent they are artificial reservoirs. I have never observed the control works at any of these lakes.

3836 It is not unusual to find more or less wet land and to find water escaping from irrigation systems, especially in the case of new projects. Wherever there is a surplus of water these conditions are very apt to be found. I have never made any observations of the rise or fall of the underground water level, but in my judgment it would not vary much. Our measurements of return seepage on the Laramie River showed almost nothing between Sodergreen's ranch and Laramie City, indicating that very little of this underground water passed towards the river, but remained on high land and evaporated or passed in another direction. These seepage investigations were made in October, 1913. We
3837 have made no investigation of the amount of water diverted between the Pioneer Dam and Two Rivers in 1913, but have made an estimate of the use of water between the two places by taking

the difference between the flow at the Pioneer dam and the flow at Two Rivers, which would involve a consideration of the amount diverted and the amount returned to the river.

3838 The only seepage measurements we have made on the Laramie River were made by Mr. Bunger at my office in October, 1913. Another measurement was made by other persons and published in Wyoming Experiment Station Bulletin No. 61 wherein it was stated that there was practically no seepage return found until the Wheatland flats were reached, when a return of 7.59 second feet between the North Laramie and Uva and of 16.15 second feet between Uva and Fort Laramie was found. The return flow in the upper valley of the Laramie above Woods Landing is probably greater than the flow in the Poudre Valley and that in the portion of the Laramie Valley below the Pioneer Dam both with respect to upland and bottom land is very much less than in the Poudre Valley, although considering the bottom lands alone it might be as great. I attribute this difference to the difference in the character of the soil and the existence of so many depressed areas on the upland and the fact that there has been little or no attempt at drainage. The soil on the uplands is very gravelly but contains enough clay or other fine material to seal the soil.

3840 The Laramie sandy loam occurs on the bottom lands and according to the soil survey report on the region covers most of the upland portion of the Laramie Valley on the north and west side of the river and I would classify it as a tight soil.

At the time my report was made it was principally for the Riverside Ranch and was in the nature of a reconnaissance and my attention was not directed particularly to the upland, in fact, it was not directed to the uplands at all except as manifest in the Riverside Ranch, and the uplands which I examined more particularly were open and loose. Since that time my examination of the upland country shows conclusively to me that the larger part of this upland is classified by the Department of Agriculture Survey Bulletin as a tight soil.

3843 If the Soil Survey Report classifies this land as open, through which the waters pass readily, I would disagree with it, because the water remains on the surface until it evaporates. These Soil Survey Reports are used largely in reconnaissance but not in final reports by engineers, and I know of no more thorough investigation of the Laramie Plains than that made for the purpose of this Soil Survey Report of the Government. In the main my investigation confirms the Soil Survey Reports showing relative to the depth of the water table below the surface in this area excepting that in my opinion the area wherein the water surface is marked as more than ten feet below the surface is much too broad. It is possible that this is due to the fact that the soil survey was made in 1903.

3845 None of the investigations upon which my Exhibits 123 to 129 inclusive and No. 131 are based were made by me personally. The greater part of these tables are based on published records. In many instances I have felt constrained to reject the

published figures and substitute estimates of my own. Some of the reports are from private and some from public sources.

3846 The reports relative to the amount of water carried through the Skyline Canal were made by the Water Supply & Storage Company, the owner of the ditch which was allowed to withdraw from the Poudre River an amount of water proportionate to the amount reported by them as being taken from the Laramie River. I do not know how much the capacity of this ditch was cut down by the re-rating in 1905, and I have not endeavored to rectify the earlier records upon the basis of the later re-ratings. My

3847 figures relative to the flow through the Sand Creek Ditch were secured from the owner of the ditch and from the water commissioner, whose figures did not always agree, and there is also uncertainty as to how much water was taken from Sand Creek and how much from Dead Man Creek.

3850 The showings relative to the Wheatland Number Two Reservoir upon Exhibit 140 are based upon an assumption of a capacity of 123,000 acre feet and my estimate that it contained 113,000 acre feet on May 6, 1913 is based upon this assumption. I have never made any measurements of the capacity of the reservoir. The dam of this reservoir could be raised perhaps 12 feet at quite a moderate cost, adding at least 70,000 acre feet to its capacity. I believe $150,000 would surely be sufficient for this work.

3852 I am familiar with the investigation of a report on reservoir sites in Wyoming and Colorado made by Captain H. M. Chittenden of the United States Army in 1897, wherein considering the proposed reservoir in Big Hollow upon the Laramie Plains and the amount of water available for such a reservoir he considered the discharge of the river at Uva, stating that the mean discharge upon a three year record was 87,316 acre feet; that 20 per cent should be deducted for inflow below Big Hollow, leaving approximately 70,000 acre feet which might be available for the proposed reservoir; that the evaporation from the surface of the reservoir would be 24,000 acre feet per annum, leaving an available annual storage of about 46,000 acre feet per annum. This report was made before the construction of Wheatland Number Two Reservoir, Lake Hattie Reservoir and James Lake Reservoir. I did not take the report into consideration in preparing my estimate of the run-off of the Laramie River because it was based upon a reconnaissance. The data at hand was very meagre, and Captain Chittenden's investigations were in the nature of a reconnaissance and his opinions have been found to be erroneous in vital particulars not only with respect to this reservoir but with respect to other projects.

3854 In 1904 I made an investigation of the resources of the Laramie River, but made no report thereon. The only conclusion I reached at that time was that there was no need of the Government undertaking any work in the Laramie Valley and that whatever development might take place along the Laramie River

would in no manner affect the proposed project of the Government on the North Platte River.

3856 I estimate that if the Greeley-Poudre Tunnel had been in operation and the Upper Laramie River system belonging to that project had been completed, 50,000 acre feet of water would have been carried from the Laramie River through the tunnel in 1911 and 50,000 acre feet in 1905, an average year. The records for 1904, 1910, are not sufficient upon which to base an estimate and an estimate based upon the discharge at Woods Landing would be very uncertain.

3857 The total amount of water which might have flowed into the Poudre River below the canyon and from the north side if not intercepted by ditches might amount to 10,000 acre feet in some years. Since utilization of such water as flows in these small tributaries, a small amount reaches the river.

3859 Water rights were originally secured from the large corporate canals in the Poudre Valley upon the basis of one cubic foot per second for 55 acres, and in some cases it was provided that when the entire capacity of the ditch had been sold upon this basis the title to the ditch should pass to the consumers. The Little

3860 Laramie River, for ten or twelve miles across the valley consists of three or more natural channels. With some expense and with the co-operation of the various owners it might be possible to combine the river in one channel which would lead to economy in the use of water.

3861 Continuous measurements of the Laramie River were made during the year 1913 a little above and a little below the Wheatland Reservoir Number Two. If the records were correct the amount of water carried from the reservoir within any period might be ascertained by deducting the flow at the upper station during that period from the flow at the lower station, and if the reservoir was full about the middle of May, 1913, the difference between the discharges at these two stations would give the amount of water carried from the reservoir during the period, and by adding the amounts of evaporation the amount of water the reservoir had held would be ascertained. Personally, however, I have not much confidence in the records made at these stations.

3862 Mr. Cogswell, who has been connected with the irrigation department continuously since 1895 has been division engineer for six years of the division including the South Platte River and its tributaries, among which is the Poudre. In his report for the year 1912 he states that that year will be recorded as the wettest known in forty years, with a more than average supply of snow in the mountains at the commencement of the season and numerous rains during the season, and a comparatively slow melting of the snow so that there were no excessive floods. That report also states that in the near future the paramount issue in his division will be the excessive waste in running water from the rivers to the irrigated lands, not more than fifty per cent of the water diverted from the rivers there for direct irrigation or for storage reaching the land, and there being an additional loss of not less than 20 per cent from the

reservoirs by evaporation and seepage, of which perhaps 25 per cent returns to the river through seepage.

3864 Redirect examination by Mr. Fred Farrar:

Referring to misunderstanding relative to sandy loams on Laramie Plains area, soil map in bulletin from Department of Agriculture shows that there are two classes of this sandy loam, one being designated as "Laurel sandy loam" and the other "Laramie sandy loam." This map shows relatively small portion of Laramie Plains area. This is area on each side of Laramie River from point near Woods Landing following down river with somewhat irregular boundaries to junction with Little Laramie River. In some places width of survey shown, at right angles to thread of stream, is as much as 12 miles. No portion of the Little Laramie River except that right near junction with Big Laramie, is shown by this survey. That land lying intermediate between two streams is not shown, other than as I have described it. Map shows soil conditions just south and also east of Lake Hattie. Soil in vicinity of that lake is characterized as "Laramie gravelly loam." An area lying west
3865 and little north of Laramie in western portion of Tp. 16 N., R. 74 W. shown by map indicates same character of soil. Big Hollow area is not shown on this survey.

Gravelly loam soil extends for considerable distance east and a little north of Lake Hattie and connects up with area marked on map as "Laramie gravelly loam," that is, this gravelly loam extends from area shown on map in southwest corner of map to area west of Laramie. Area designated as "Laurel sandy loam" seems to be in general way mostly on south or east side of Laramie River and forms what are generally termed bottom lands.

Mr. Farrar: I desire to read into record from page 11 of this bulletin being entitled "Soil Survey of Laramie Area, Wyoming," published by U. S. Department Agriculture, Bureau of Soils, showing on title page that field operations of that Bureau were made in 1903. Under title "Laurel sandy loam" appears following: "The natural drainage, except in the higher places is comparatively poor. During the wet season the type is subject to overflow from the Laramie River, while owing to its low lying position the water table is near the surface most of the year. At the time this soil
3866 was surveyed the water table was rarely found at a depth of more than six feet.

A system of artificial drains that would be effective during the dry season both in keeping the water table sufficiently below the surface to allow the growth of shallow-rooted crops and in removing the alkali would be of great benefit to this soil type. These drains would not only free the soil of alkali already present, but would check the further accumulation of alkali within the root zone of plants. To be most effective these drains should be laid as deep as the level of the river would permit."

(Defendants' Exhibit 154, soil map of Laramie area, offered in evidence.)

Mr. Farrar: In connection with same bulletin, I desire to offer in evidence map or plat which is labeled underground water map, this latter being portion of same bulletin mentioned. This map or plat will be marked:—

(Defendants' Exhibit 155, offered in evidence.)

From legend on underground water map, Defendants' Exhibit 155, it appears that areas which are colored light green represent countries where water is less than 3 feet below surface. Area which is colored yellow represents territory where water is from 3 to 6 feet below surface. Other depths are also indicated in different areas. According to this survey, water table comes nearest to surface, generally speaking, in areas marked green and lying along line of Pioneer Canal, beginning within about 3 miles at head of Pioneer Canal and extending almost continuously for some
3867 9 miles. Again there is considerable area starting at point 9 miles southwest of Laramie and extending some 6 miles north of town of Laramie. These areas are mostly on lands of higher elevation. For considerable portion of area shown, and particularly from upper end of survey down to approximately 8 miles above Laramie, land in which water comes near surface lies from 1 to 6 miles from river. Location of areas in which, according to map, water comes within less than 3 feet of surface, is about same as special areas which I had in mind in my testimony, although map does not extend quite far enough to take in all of the territory I mentioned. The two maps I have just mentioned, Exhibits 154 and 155, coincide as to area covered. These areas in which water table comes to within less than 3 feet of surface occur in large part in area marked as "Laramie sandy loam" on soil map, Exhibit 154.

The survey covered by Exhibits 154 and 155, was made in 1903. In my judgment effect of continuous irrigation from that time to present time would be to cause water table to rise and the wet area to be extended.

3868 Mr. Farrar: I desire to read into record from this bulletin, certain references under head "Laramie gravelly loam", commencing on page 17:—"The soil of the Laramie gravelly loam consists of a coarse sandy loam mixed with large amounts of gravel and varying in depth from two to three feet. The color ranges from yellow to dark gray, the latter color predominating. The subsoil consists of sand and gravel and extends to a depth of more than six feet. On the surface the gravel making up so large a part of this soil varies in size from small pebbles to boulders about twelve inches in diameter. In the deeper layers the gravel is much larger and increases in size with depth."

Again on page 18: "Owing to the large percentage of gravel in this soil, it is not a desirable type for farming. It is used almost entirely for grazing purposes, although in the lower areas under the Pioneer Canal some hay is produced. The yield is about the same as on the other low lying soils of the valley".

Defendants' Exhibits 109, 110, 111 and 112, photographs intro-

duced by defendants in connection with evidence of Professor E. B. House, illustrate character of this "Laramie gravelly loam". I was present when these photographs were taken.

Am able to make comparison between actual tests made in behalf of defendants to determine depth of water table from surface, with this survey, and able to determine whether or not water table has arisen since survey was made, insofar as this particular point is concerned. A soil sample was taken from near S. W. corner
3869 of Sec. 21, Tp. 15 N., R. 74 W. Water was found at depth of about 3½ feet. Underground water map, Exhibit 155, shows water to be more than 10 feet. Particular point where this test hole was sunk, is shown on Defendants' Exhibit 106, being about center of picture in very near foreground. Test was made upon one of alfalfa fields of Hart Ranch. That is also shown in photograph. Photograph was taken July 16, 1912.

My testimony relative to seeped areas in Laramie Plains area, was in nature of a criticism of failure to take any steps to utilize this seepage water. Such facilities of obtaining water supply, coupled with reclamation of seeped lands, have not been overlooked in Poudre Valley in Colorado. They have been utilized and the attack has been made to eliminate it as far as practicable. Drain ditches have been dug in that Valley for purpose of reclaiming lands and securing the water, and the fact that the land was benefited was a secondary consideration.

I testified to various gauge readings from many sources, some from State Engineer of Wyoming, some from United States Geological Survey, some from Assistants to State Engineer of Colorado and others from still other sources. If doubt is cast upon fidelity of gauge readers, speaking in abstract, concerning all records, both those of United States Geological Survey, other United States Bureaus that use this system and all state and other records, it would result in efforts to obtain data being useless, but not entirely useless but would result in less than their probable cost.
3870 The human element and a possibility of mistakes must of necessity enter into all calculations of this sort wherever and by whomever made. We must trust to the faithfulness of the observers as in all other lines of investigation.

In compiling a table showing total discharges for any period, gauge heights and velocity of current are really the basic data and the published or unpublished discharge measurements are nothing more or less than conclusions derived therefrom.

Hutton and Creighton Lakes, in which I stated water had been impounded from Sand Creek, have not been used up to present time for storage of water for irrigation. Any water which has heretofore been impounded in these lakes from Sand Creek, was entirely lost for irrigation purposes.

Amount of water which might be diverted in any one year does not have any direct relation to amount of seepage or area of seeped lands in that particular year.

The flow of underground waters is very slow. Several years are

generally required for water to make its appearance and for effects to be observed. If return seepage or water flowing into depressed areas was carefully observed, I do not believe that anyone from such observation could state that the action or use of water in any one year was responsible for the seepage. Water which does appear is result of a number of years of observations.

3871 It would not be economical to construct ditches large enough to carry the maximum floods of the Poudre River. It would not be within reason, physically possibly. Of necessity a certain amount of peak of floods of Poudre River must pass out of Poudre Valley, unless you could construct channel reservoirs. Amount of water coming from other sources, combined with these peak loads or floods of Poudre River, would make construction of such a reservoir feasible. But to construct simply to conserve these peak floods would not be feasible.

Cost of any system of reservoirs on Poudre River capable of conservation to that Valley of any considerable portion of these peak floods would be very large indeed. Stove Prairie Reservoir which is considered cheapest channel reservoir now available, would require dam about 175 feet high. Such a dam would cost about $1,000,000 or more. That is one of proposed reservoirs for Greeley-Poudre System.

Sufficient water from Poudre River under normal conditions is not available for irrigation of lands of Greeley-Poudre Irrigation District without the addition of the water which it is pro-

3872 posed to divert from Laramie River through the tunnel. I have previously explained that possibility of acquiring this water for the Greeley-Poudre Irrigation District, has made it possible to construct expensive works on Poudre River itself to conserve, among other waters, that water which now runs to waste.

Aggregate capacity of reservoirs of Poudre Valley is not measure of amount of water needed in that valley for irrigation, by far larger part of water needed in valley is not stored at all but is used by direct flow from river. Fact that on November 1, 1912, there appears to have been, according to State Engineer's office of Colorado, 83,790 acre feet in storage in reservoirs in Poudre Valley, does not indicate a surplus of water during irrigating season of that year. It is possible that amount of water was stored after insistent demands of ditches had abated somewhat and that water, or a part of it, had been placed in reservoirs after that demand for direct uses had ceased in part. Draught on reservoirs late in season is modified by amount of precipitation at that season of year, to some extent.

East and West Side Collection Ditches of The Greeley-Poudre Irrigation District System on Laramie River could not be kept open during winter for same reasons that Sky Line Canal of The Supply and Storage Company has not been kept open. I judge this in part from evidence given by witness Edwards.

3873 Poudre Valley has utilized its opportunities for securing and storage of water from that stream. It has utilized all sources of supply as it has been financially able so to do.

Water brought into Poudre River and tributaries through various

inter-watershed ditches now constructed and in operation, is measured by water commissioners in charge, usually by deputies. Amount of water which enters from these other sources is measured and a check kept upon that amount. Water commissioner must know that quantity in order to make proper deduction and a direct delivery. He deducts certain percent of water which enters his district and makes deduction for loss in transit before delivering water belonging to inter-watershed ditch companies.

Poudre Valley is not entitled at all times to all available water of Poudre River. Ditches on South Platte River below mouth of Poudre, are, some of them, prior in point of date of appropriation and, when there is scarcity of water on main river, ditches of senior date on lower river have not sufficient supply and the junior ditches on tributaries must be closed down to supply that deficiency. Further than that, reservoirs on Poudre River are some of them later in priority than some of ditches on South Platte River and they are not permitted to store water when ditches senior in point of priority to the priority of the reservoirs, need water.

3874 It is contended, though not settled, that junior ditch is entitled to water for direction ahead of senior reservoir.

Seepage measurements taken on Laramie River in Wyoming either by Wyoming Experiment Station or my hydrographer, shows that very little seepage returns to river. Ultimate conclusion is that water which accumulates in seeped places evaporates.

Have testified that in computing flows did not charge against stream either water which was used by ditches in Laramie Valley in Colorado or, on the other hand, water which was used by ditches on Little Laramie and its tributaries in Centennial Valley in Wyoming. I did not take into consideration either, water which is used by ditches intervening between Boswell's Station and Woods Landing. In both instances, that is, in Colorado and Wyoming, I have not charged against either Big Laramie or Little Laramie the use of water in upper reaches of stream and above Woods Landing Gauging Station on Big Laramie and above Hatton Station on Little Laramie.

3875 Referring to my report of 1910 for Riverside Ranch, Northwestern Land & Iron Co., and The Denver, Laramie and Northwestern Railroad Company, are practically one enterprise. The Land & Iron Company was composed largely, if not entirely, of same people constituting other company. The Denver, Laramie and Northwestern Railroad was designed to construct from Denver to Laramie and thence westward. Exploitation of lands was an incident with the enterprise. The Railroad Company today is in hands of a Receiver. I believe both the Railroad Company and The Land and Iron Company are insolvent. Statistics and returns and data incorporated in the report, I obtained from Agricultural Experiment Station Bulletins of Wyoming and from Professor Olin who was at that time employed by the Northwestern Land & Iron Company. He was an agricultural booster for whole enterprise and employed by company to look after certain operations, that is work of development of lands owned by it. This report was en-

3876 tirely exparte. Object of report was primarily to pass upon water supply. Questions asked me whether they had good

water supply for Riverside Ranch and incidentally they asked me to make suggestions relative to how property should be handled and disposed of.

Report was not designed or intended to cover anything more than the proper handling or disposition of Riverside Ranch. It was made May, 1910. Predictions or estimates of capability of section upon which I reported, have not materialized during four years since report was made. Report was made at time when there was what you might call a boom in agricultural lines all over the west. There was good deal of enthusiasm and optimism abroad at that time and I fear that all of us were a little too optimistic. As far as Riverside Ranch is concerned, I believe that property could be divided up into tracts of 160 acres or more as I suggested, and that, in combination with ranch operations, cattle and sheep, one owning such property would be able to succeed. Laramie River passes through length of
ranch. It is one of best ranches on Laramie River. I visited
3877 it in 1913. There had been no improvement or development on this ranch since my reconnaissance of 1910. I hardly think it in as good condition today as in 1910. There were one or two settlers on ranch in 1913 that were not there in 1910, but I think that was about all on the entire ranch. Not all of ranch houses on different portion of ranch were occupied during my visit of 1913. Occupation of ranch houses was about same in 1913 as in 1910.

My opinion as expressed in 1910 relative to water supply has been confirmed by my investigations in 1913, to effect that no matter what outcome of litigation should be, there was ample supply for ranch not only for older ditches, but also for their newer ditches and for extensions thereof. There is no danger whatever of them ever being short of water supply on that ranch. By litigation I refer to this case and contests that had been started at that time relative to appropriations of water for ranch. These contests being over adjudication of water rights in Wyoming. In portion of report read by Mr. J. D. Clark in my cross examination, I stated that there were ditches diverting water in Colorado from Laramie River in water district No. 48, with aggregate capacity of 563 cubic feet per second. I referred
to valley ditches on Laramie River itself and not to inter-
3878 watershed diversions. These ditches have priorities decreed under laws of Colorado and all of them prior to 1902. Fact that these decrees are for excessive amounts does not change flow of river. A decree does not necessarily mean that there is that much water is river, neither does a decree put water in stream. By acreage of 4720 acres stated in my report was obtained from water commission's reports. Have had occasion to modify that during progress of this case.

Mr. Wortham, one of witneses in this case, made surveys of Laramie River Valley in Colorado and, if I remember his testimony correctly, stated there were 3200 acres irrigated on Laramie River itself in Colorado and 960 acres on Jimmy and Grace Creeks. This makes total of 4160 acres. Regardless of exact figures I have given, I refer to testimony of Mr. John R. Wortham and the exhibits introduced, same being plats of his survey. That includes all land on Laramie

River area in Colorado under irrigation. That is practically all the land that can be put under irrigation in Laramie Valley
3879 in Colorado. It would then make no difference whether or not these decrees are excessive, even if they should be ten times as excessive as they are at present time. Use and necessity would be just the same and, even though an excessive amount might be diverted, it would return to river very quickly.

Diversion through the Wilson Supply Ditch and its correlated ditch, the Sand Creek or Divide Canal, does not make any very great difference on flow of Laramie River. Amount diverted by that system, is small, in any case, and when merged with other supplies and considered in connection with them, percentage of difference would be very small even though Divide Ditch diversion was entirely included. If there is any doubt as to amount which this ditch takes from upper reaches of Deadman Creek, and also amount which it later takes from Sand Creek, there nevertheless would be practically no difference in general effect on stream. One or two percent. would probably cover any differences. The water from Sky Line and Sand Creek or Divide Ditches is brought across the divide into the Poudre Valley and is stored. Discharge is equalized and regulated by storage.

JOHN E. FIELD.

Recross-examination by Mr. N. E. Corthell:

3879 Mr. Olin, to whom I have referred in my testimony, was for a number of years a professor in the Colorado Agricultural College at Fort Collins, and at the time I made my report upon the Riverside ranch was supervising some agricultural operations there.

3880 Redirect examination by Mr. Fred Farrar:

In making my estimate relative to these seeped or saturated areas, I did not consult the map which has been referred to and offered in evidence, either in whole or in part. The map rather corroborates and coincides in part with my own ideas.

3881 JOHN R. WORTHAM, recalled.

Direct examination by Mr. Fred Farrar:

Some work was started on Greeley-Poudre tunnel and on approach cut to tunnel on Laramie River side, with force of men and teams after commencement of taking of testimony in this case. This work will be completed so as to divert water by May 1, 1914.

3881 Cross-examination by Mr. N. E. Corthell:

The work in the vicinity of the tunnel of the Greeley-Poudre system which has been performed this winter was commenced January 8, 1914, and 60 per cent of the work then remaining incompleted has now been completed. This work has been on the cut

from the river to the tunnel itself, cleaning out the tunnel and upon the diversion dam in the river channel.

Redirect examination by Mr. Fred Farrar:

We endeavored to get a crew of men in there for work earlier than date upon which actually started. Attempted to get outfit there last two or three days in November, but on account of excessive snows, it was absolutely impossible and we had to make another attempt. We finally shipped outfit by rail from Greeley through Laramie to Mountain Home, a station on the Laramie, Hahns Peak and Pacific Ry., and from there outfit was sledded in to west portal.

3883 L. G. CARPENTER, recalled.

Direct examination by Mr. Fred Farrar:

Can give specific data on snow measurements little more readily today than I could have done last night. April 3, 1913, snow varied from 48 inches to 20 inches. There are great many other cases along there. Near Wyoming-Colorado line, near Wycola or Mountain Home, we had series of measurements running about same way, 38 inches, it was a little more uneven. April 4 we had measurement of 50 inches at elevation of 8300 feet. This was on ridge. At one place where snow had blowed away, it ran as high as 16 inches. Most of measurements ran in neighborhood of 36 inches on average, some as high as 56 inches and some as low as 16. On April 8, at one place we had measurement of 54 inches and at another place 50 inches. One place was 24, another was 50, another 36, another 50, etc., all along in that general section.

In May, we had series of measurements running about same, at about 3 feet. Measurements of May 1 were not very far from town of Centennial, Wyoming. Trip was made at that time to Medicine Bow Peak. Measurements cover from May 5 or 6 up to May 10. For instance on May 7 here at one spot it was noted that snow was 3½ to 4½ feet deep. Those are extremes. At one place 3 to 4 feet is noted. At another place 5 to 4 feet is noted. At another place 4½ to 4, 6 to 5 etc. Measurement Number 96 runs from 5 to 4 feet. Measurement Number 97, 6.2 to 6 feet.

3884 These measurements were made at different points as observer passed along. They were made quite frequently, so far as these test depths are concerned. For instance on May 7 there were something like 13 different tests of measurements of snow made as Mr. Morey proceeded and at each of these spots depth was taken from 3 to 5 times. If snow was uniform, one measurement was taken. If depth varied, more than one measurement was taken to show variation.

At some time during the day or while observer was in that general vicinity, a test of amount of water in snow was made, in addition to the depths. Test of water content was not made as frequently and did not have to be so frequently made, because that covered somewhat the same general conditions.

These measurements were all on Medicine Bow Range, the ridge between Little Laramie River and North Platte River. There were also numerous others. There were cases where snow had been drifted or blown away.

In 1913 in valley above Centennial, crossing this region from there to Medicine Bow, tests were made starting from Centennial to Medicine Bow Peak and back, ranging as follows: First measurement not very far above Centennial was one foot in depth, then at Number 137 we have 2½ to 1 foot in depth. This was on May 4. First measurement was on May 3, 1913. At point Number 140 snow was 2 to 1 foot in depth. At Number 146 from 3.2 to 2 1-5 feet. At 147 it was 2.65 feet in depth. At Number 151 it was from 3½ to 1½ feet deep. This gives an idea of the ranges of
depths. The numbers refer to my serial number as we made
3885 them consecutively in note book. Number 153 was 5 to 3½
feet; Number 155 which was at this time about 10,000 feet elevation, varied from 10 to 5 feet; minimum was 5 feet and maximum 10 feet. Number 158 was from 6 to 2½. Number 160 was 5; Number 161 was 3.2; Number 162 was 6 to 3¼ feet, that was at a lower elevation. Number 165 ranged from 5½ to 3½, that was about 400 feet lower than previous one. Number 166 was 5 to 3 feet, that is slightly lower. Number 168 varied from 4 to 3 feet, that was 100 feet lower. Then going only 100 feet higher, it varied from 10 to 2 feet. Wind had evidently given it a sweep. Each of these serial numbers refers to point where a number of measurements as to depth were made. At least three measurements were made at each station as a rule. I am giving the extremes of the various measurements. Blanks I had prepared were arranged with spaces for three measurements at each point, but, if there was any material variation, more measurements were taken. Number 174 was from 6 to 5 feet in depth. Dates of last ones I am now given- were a little later in month. Number 173 was on May 30 and show it from 6 to 5.3 feet. That is not over 10 miles west of Centennial on way to Medicine Bow Peak. These measurements on this trip were within 10 to 15 miles of Centennial.

The mountain range at head of Little Laramie River at Centennial and west from there and also south to state line is rather broad,
and a flat top. That is shown in some of these photographs
3886 that may be presented in evidence. On side next the valley,
there is quite a steep de-cent. The Laramie, Hahns Peak and Pacific Ry. climbs that grade somewhat diagonally, but when it reaches top, it travels over rather a flat open country and, while this country is more or less rough in places, yet that illustrates the general characteristic of the range which is flat and rounded out.

The Medicine Bow Range is broader in Wyoming than in Colorado. At headwaters of Laramie River in Colorado, this range is very narrow. From Chambers Lake to Clarke's Peak distance is only 4 miles. Clarke's Peak forms crest of range. From Clarke's Peak range broadens as it goes north, but still preserves appearance of mountain peaks.

Medicine Bow Range is timbered in Wyoming and partially in

Colorado. In Colorado this range runs above timber line and this group surrounding Medicine Bow Peak in Wyoming also runs above timber line. There are a few peaks above timber line in both places but more in Colorado than in Wyoming. The Laramie, Hahn's Peak and Pacific Railroad crosses ridge practically at interstate line. I think the downward slope begins there.

Have photographs illustrating snow condition.

(Defendants' Exhibit 156, album of snow photographs, offered in evidence.)

3887 On each of these photographs there appears to be a number, for example, 2.201. That is simply my filing number at office for reference and identification for obtaining negative. They are all numbered.

Photograph Number 2201 is view taken May 7, 1912, from head of Medicine Bow Creek, looking west over top of that ridge. That is ridge between Little Laramie River and North Platte River. It shows general flatness of that ridge, that it is devoid of peaks and not very much broken up for a mountainous country. Mountains in background are correctly labled on face of picture.

Number 2202 is photograph from same point but looking southeast and shows snow at that time. Picture shows country looking southeasterly and rather up than west of Little Laramie. It is the flat top range between Little Laramie River and North Platte River.

3888 Laramie Plains would be at east or northeast of this point of view. Objects appearing like shrubbery, coming through snow are trees not covered by snow in both of these pictures.

Number 2203 is view taken from point further up and shows snow range or Medicine Bow mass a little to west of observer. This picture was taken at 10 o'clock. Point of view is N. E. ¼ of Sec. 18, Tp. 16, N., R. 79 W.

Number 2098 is in vicinity of Medicine Bow Peak and shows outlying portion of that mass. Taken May 7, 1912.

Number 2099 is another picture in Medicine Bow Peak country. It shows part of Peak shown in previous picture, but from higher elevation. This is from an elevation of mountain mass and shows trees and snow and snow depth at that elevation. Mountains shown in pictures 2098, 2099 and 2203 are above timber line. That is above point where trees will grow.

Mr. Farrar: In connection with these photographs specifically described, I desire record to show that exhibit includes pictures Number- 2204, 2206, 2208, 1975, 1953, 2205, 2202, 2073, 2210, 2095, 2096, 2092, 2089, 2075, 2074, 2097, 2086, 2064, 2100, 1940 and 1945.

3889 All pictures in series above designated are in Wyoming on west side of Little Laramie River Valley and on ridge or range that is watershed between Little Laramie River and North Platte River. It is the contributing area to the Little Laramie River. Legend on each picture contains correctly date and location.

Took some photographs in Colorado at a later date and these do not make fair comparison of two areas at same time. We did have some pictures taken in Colorado in March and April, not covering very large area, and I think others were mostly taken in June, except just along Laramie River itself where some were taken in May.

Photograph Number 3037 was taken from ridge at head of Laramie River, west of Chambers Lake and looks down into that lake. At left side is Laramie River Valley proper and whole view covers region very similar in foreground to Laramie Valley. Mass of mountains in background is on watershed between Poudre River and Big Thompson. At left of this view and in middle ground, is ridge between Laramie River and Poudre River. Photograph taken May 30, 1913. At extreme left is Laramie Lake, which has been referred to in testimony, and waters flow from it into Laramie River.

Photo Number 3038 is view from peak above timber line and somewhat to northwest of point where 3037 was taken. It
3890 was taken after climbing nearly one hour after taking 3037.

Photo Number 3039 is view from same place as 3038 but in different direction. 3038 is view looking south and shows Clarke's Peak which is at head of Laramie and on divide between North Platte on west and Laramie and Poudre River on east or left. Waters from Clarke's Peak drain into three different directions and into North Platte, the Poudre and Laramie.

Photo Number 3040 is another view from same point. These three pictures taken together with three following, all overlap and form a picture around the horizon, forming a panorama. Photo-3040 is a view looking approximately northwest.

Photo Number 3041 is a little more northwest, that is north of west, and shows watershed which drains into Laramie River through either McIntyre or Rawah Creeks.

Photo Number 3042 joins 3041 and is looking north. At right hand of this picture is shown valley of Laramie River going to north and at extreme right is ridge spoken of as Green Ridge or Laramie Mountains. It is through this ridge that tunnel passes.

Photo 3043 joins photo 3042 on right and looks across Green Mountains or Green Ridge (Laramie Mountains) and shows valley of Laramie River in foreground. The little light spot in left hand is pool of water at storage dam at tunnel.

All these photographs were taken May 30, 1913.

(Defendants' Exhibit 156, album of photographs showing upper Laramie River Valley in Colorado, offereed in evidence.)

3891 Medicine Bow Range of mountains in Wyoming for same elevation, is as good if not better than same elevation in Colorado. There is a large area of that elevation in Wyoming, because ridge is broad, than there is in Colorado. In Colorado, in vicinity of Clarke's Peak, there is some area that is better than this in Wyoming. I reached the conclusion without having as much data as I desired, that a large portion of the Medicine Bow Range from Clarke's Peak to state line is not as good as that portion of the range

in Wyoming. This includes that portion of The Colorado Range south some 15 miles from interstate line.

Notwithstanding the fact that Wyoming portion of range is better than Colorado, there is very considerable run-off through streams which enter river from the low portion of range in Colorado. Stuck, Grace and Laramie and La Garde Creeks all enter Laramie River from this low portion of Colorado range.

That portion of range of higher elevation in Colorado which is best drainage area is not very extensive. Region in vicinity of Clarke's Peak is highest portion of this whole range and precipitation on that in form of snow is rather more than at the lower elevations. It is analogous to the situation in the case of Medicine
3892 Bow Peak in Wyoming. I think that the precipitation at the elevation at Medicine Bow Peak in Wyoming is relatively more than the precipitation at the same elevation at Clarke's Peak in Colorado.

Examination by Mr. Delph E. Carpenter:

I have included in album Exhibit No. 156, some photographs showing Sky Line Canal or portions thereof and also some of upper Rawah Canal. Photographs Nos. 2232, 2237 and 2252 represent Upper Rawah Ditch. Taken June 21 and 22, 1912. They show character of country through which ditch is constructed and snow conditions on that date. Show snow banks in ditch. Photo Number 2230 is picture of headgate of Sky Line Ditch taken June 21, 1912. Photo Number 3143 respects a portion of Sky Line Ditch. Ditch is shown in photograph as white line from snow banks and ice. It was taken June 12 from opposite ridge and thus looks across Laramie Valley south of point where West Laramie forks to west.
3893 The ditch is something like 500 feet above bottom of valley and thus as point of view is considerably above ditch by probably 1000 feet or more, it does not make slope appear quite as steep as it actually is. Slope is very steep. That is evident by looking a little further to left somewheres about middle of picture and seeing slant of these lines of ice and snow. Point at right hand side of picture is at forks of two streams, that is West Laramie and East Laramie. Through that ridge the ditch goes by a tunnel.

Photo Number 3146 is taken from same point as photo number 3143, only in this case, view is almost to north, looking down Laramie Valley towards Wyoming line. On cliffs at left hand side of this valley is seen Lower Rawah Ditch as it comes from the Lower portion of Rawah Creek and follows along side of these cliffs and with water running towards us as we stand. This ditch empties into the flat space in the central foreground, which is a portion of the reservoir site. That is the dam site where tunnel reservoir outlet is being constructed.

Lower Rawah or West Side Collection Ditch of Greeley-Poudre Irrigation District System finally reaches floor of valley at site of this dam indicated in central foreground. Of course slope of ditch is toward us. Farthest point of ditch is at an elevation sufficient

for water to run this way. From time to time lines of excavation upon this canal seem to be broken where line meets pro-
3894 jections of rock. At some of these places are tunnels. This picture does not impress one with the steepness of the mountain upon which the canal is constructed. The impression is not the same as when a person is looking on the ground or climbing these cliffs. The sides of the valley are very steep and, in looking down in this way, it sort of flattens them out. This picture was taken from a point part way up Green Mountains on east side of Laramie River on June 16, 1913, same as previous pictures.

Most complete records I have of Little Laramie River and its very favorable watershed, the records with which I am best acquainted, are those of 1912 obtained on Little Laramie River at Filmore in that year and at which place I made a good many measurements and had kept daily records. At that point drainage area is about 163 square miles or 104,000 acres. Run-off in month of June alone was 76,632 acre feet and in July 27,676 acre feet or a run-off of practically one foot in depth for those two months, June and July only, for entire drainage area.

I have a hydrograph showing flow in Little Laramie River by itself, at this point, from a period of May 20 to some time in October when our records of the stream heights ceased.

3895 (Defendants' Exhibit 157, hydrograph of Little Laramie River at Filmore, Wyoming, offered in evidence.)

Exhibit 157 represents flow of Little Laramie at Fillmore, Wyoming, and shows as other diagrams of same character, flow in cubic feet per second for each day during that period from May to October. Vertical heights represent quantities in cubic feet per second and horizontal, as shown, days of month. Diagram is colored in part, so as to make it easier for eye to discern.

Run-off of Little Laramie River, as illustrated by this hydrograph, confirms my conclusions relative to flow of Little Laramie River drainage area in its general relation to run-off. My first impression about little Laramie River had been that it was not a very good stream, but, after going over it carefully, going over the watershed and seeing the water that comes down, it caused me to see that my first impression had been very far wrong. My first impression was possibly aided by manner in which that stream is generally spoken of, as Little Laramie, whereas it is quite comparable to the main Laramie River in some respects.

Spoke last evening of having made series of measurements during year 1912 at Boswell's Station, also of fact that my measurements at that station varied with those published by State Engineer of Colorado. I gave reason for variation. I have caused to be illustrated by hydrographs the differences between the published records of State Engineer of Colorado and records as ascertained by
3896 me from actual measurements.

(Defendants' Exhibit 158, hydrograph showing flow of Laramie River at Boswell's Station, 1912, offered in evidence.)

Exhibit 158 shows flow of Laramie River at Boswell's Station in year 1912.

Portion of diagram that is colored yellow, lower portion, is that shown by published record given in State Engineer's report of Colorado for 1911-1912. Upper line represents that as found by measurements that were made by me or under my direction during period of high water. As explained last night, during period of high water, State Engineer of Colorado, or measurements made under his direction or those which were published, did not include any measurements of the stream. There were gauge heights recorded by an automatic machine which was out of order, or tended to get out of order, and, as I then mentioned, depth as we found varied somewhat from machine, and, in addition to that, there was quite a large quantity of water flowing under three bridges or culverts across the bottom, that were not included in the river under the bridge. The upper portion of this diagram which is colored red, is the difference then between the quantities as published in that report and the quantities as I found them and is practically the same as the quantities as we found going through those culverts and going around the main gauging station.

In speaking of the published record, I refer to that published by Charles W. Comstock as State Engineer of Colorado for years
3897 1911-1912. When I speak of the amount going around station I refer to the discrepancy between the figures as published by the State Engineer and the measurements we made. Amount going under third span of bridge at those depths is not very great and certainly not as great as that going through the three culverts. This excess may be due to almost entirely the amount going through the culverts. At any rate it is the discrepancy between these results as published and the results as we found them. As I stated, the automatic instrument was in error, but I think the published records had attempted to correct those heights, but in converting the heights into quantities, they evidently had not been acquainted with the fact that a great deal of water went around the bridge and would not be shown on the oridinary rating curve. I am advised that Mr. Field in testifying to the run-off of the Laramie River at Boswell's Station for 1912 used my measurements on the ground rather than published record. I do not know, however, as I did not hear his testimony on that particular point.

Mr. Delph E. Carpenter: In order that record may be clear upon this subject, Mr. Field being present in the room, I will digress to ask Mr. Field what figures he used, those as obtained by Professor Carpenter from actual measurements in 1912 or those published by State Engineer Mr. Comstock.

3898 Mr. Field: I used the data as used in compiling the published reports, in so far as they related to gauge heights. I used the discharges for the high water measurements as determined by Professor Carpenter.

(Witness continuing:) I had occasion to ascertain amount that

might be diverted by Greeley-Poudre System of Collection Ditches and tunnel as now being constructed and completed in the Laramie River Valley in Colorado by the Greeley-Poudre Irrigation District, and incidentally had to look into amount passing interstate line. Do not think I drew a conclusion in percentages but figures I reached would only be needed to be converted into per cent. So converting those figures I find that about 23½% of the run-off of the Laramie River in Colorado would be diverted by the Greeley-Poudre Irrigation District System. This 23½% represents amount that might be obtained by means of the tunnel as a passing way, the tunnel reservoir and the collection ditches that were under contract at that time, (1909), that included what is known as Upper Rawah Ditch and its extension to McIntyre, the small portion of McIntyre that it would capture. That did not include the possible extension of Lower Rawah or West Side Collection Ditch from Rawah Creek to
3899 McIntyre Creek. I made this computation and estimate during winter of 1909-10 from data available at that time and prior to obtaining of recent data.

Complaint is made in pleadings in this case that citizens of Colorado are diverting water from Laramie River to alleged injury of citizens of Wyoming. There are instances, other than those I have already mentioned, from Fish Creek, where citizens and residents of Wyoming are diverting and using waters originating in that state to the detriment and injury of citizens of Colorado.

There are quite a good many such diversions on Crow and Lone Tree Creeks in Wyoming, which are tributaries to South Platte and have quite a long list of appropriations in Wyoming, and in addition there are quite a good many appropriations or decrees that have been adjudicated to rights on Dale Creek and various tributaries of the Cache la Poudre other than Fish Creek.

Do not know extent of reservoir constructed by City of Cheyenne diverting portion of flow of Crow Creek. Outside of that reservoir there are a good many rights on Crow Creek for irrigation and other purposes, so I presume that structure don't take all the water. There are a good many acres that are irrigated from Crow Creek in Wyoming and I do know also that in Colorado Crow Creek has practically no water. Almost every time I have seen it it has been without water.

A number of rights for diversion of water within Wyoming from Dale Creek have been granted by authorities of that State.
3900 These rights have been granted and use is made of waters of this creek in Wyoming, notwithstanding shortage of water in Cache la Poudre River, of which Dale Creek is tributary. Dale Creek is tributary of the North Poudre and both the North Poudre and the Poudre River have been short of water for a portion of the year, for many years. That is especially true of the North Poudre. Dale Creek is a tributary of the North Poudre, is a flowing stream throughout its length and the water that is used and taken out in Wyoming, undoubtedly depletes the stream in Colorado and there are existing rights in Colorado. The adjudicated rights in Wyoming on the stream not only run back for a number

of years, but are being continuously increased and adjudications are being made from year to year up to present time. I believe there were some rights adjudicated last year. By adjudicated, I mean certain water rights were quieted and confirmed in owners by Board of Control of Wyoming, even as late as last year. I mean users have conformed to laws of Wyoming and their rights have been so confirmed.

I have in my hand a list of adjudicated rights on Dale Creek and tributaries in State of Wyoming, obtained from Secretary of Board of Control of that State. 111 ditches, are mentioned in this list of adjudicated rights, as having been given decreed water rights out of Dale Creek and tributaries in Wyoming. This does not include those ditches which have permits but have not gone to final adjudication. There are a good many such permits which have been issued and are outstanding but upon which final proof has not yet been made.

3901 Diversion of water of this interstate stream continues in Wyoming, notwithstanding shortage on the same stream in Colorado.

Fish Creek is a tributary of Dale Creek and the diversions on the former are included in those just given. On Fish Creek Wyoming appropriators have not only diverted water from Creek for irrigation of lands within the drainage area of Fish Creek, but even more, they have diverted waters of Fish Creek for application upon lands lying outside of its drainage area and in the drainage area of Laramie River, as shown on Exhibit 50 of Defendants.

Water is diverted from Cache la Poudre Drainage basin into Laramie River Basin in Wyoming.

Dam for reservoir of water system of City of Cheyenne, furnishing water for Fort Russell and Cheyenne, was constructed within the last few years, three or four years ago. The use of water by Fort Russell I believe has been enlarged and connected. These diversions are from Crow Creek and tributaries. They are from one of the tributaries of the South Fork of the Platte River, which tributary joins the South Platte in Colorado a little east of Greeley.

Have obtained further information concerning instances of diversions of water made from one stream and carried over watershed to another stream for application, other than those already given. They are simply illustrative of the same general rule that I have been attempting to show to be universally true, which is, that wherever there is an occasion to use the water, whenever there is a need of water, people are going to obtain it from the stream that is nearest to them or the stream that is most accessible physically and financially and, whether a divide stands in the way or not, does not cut any figure, any more than it requires more capital.

I have not made any particular search, but I have noticed many since testifying. Did not note them all down but took them

3902 as being illustrative of the same general principle. I have found cases of physical and possibly financial obstacles, but thas has been all.

There has been no difficulty or opposition from fact that water

was taken across divide. I might mention a number of cases, for instance, in state of Oregon there is a ditch that has been built for a number of years, but takes water from upper tributaries of Burnt River and carries the water across the divide into Willow Creek. Willow Creek is a tributary of Matheur River. There are other projects on Rogue River in southern Oregon, these I may have mentioned previously, but I have recently obtained fuller information concerning them.

Rogue River runs from southern Oregon into Pacific Ocean. Kalamath River starts in Oregon and runs into California. There is one case where a ditch has already been completed carrying water from Kalamath basin into the Rogue River valley and there have been one or two others that are projected, surveyed, permits granted and some steps taken towards construction. There are two or three of these projects which are of considerable size.

There is another known as the Teel Irrigation District in
3903 Umatilla County, Oregon. In this case they propose to take water from tributaries of John Day River, carrying it across the divide into Butter Creek and then to irrigate land with this water near the Umatilla Government project in Oregon. This enterprise is projected. It is in a state of suspense waiting for funds, but the permissions have been granted and everything is ready to take up construction upon obtaining of funds. These projects are in Oregon. I have maps of all these projects but unfortunately have mislaid them.

There are a number of illustrations of inter-watershed diversions in the Islands of Hawaii that are indicated by a recent government report of the U. S. Geological Survey, that is, one of the water supply bulletins, on the Island of Oahu. This island is about 35 miles north and south and has a rainfall much larger on one side than on the other, so that in this case they are taking water from the side where rainfall is greater or at least are applying water to lands intermediate. They take water from the watershd flowing into the Pacific Ocean over to another stream which flows into
3904 the Pacific Ocean at another place. They divert water and apply it in entirely different watersheds. On the Island of Kauai there are quite a number of similar cases. The Kehaha Ditch carries water of at least one stream and over into an entirely different watershed for application. The Olokele Ditch takes water from river of same name at elevation of about 1300 feet and carries over to the south, crossing a number of intermediate streams each of which empties into the Pacific by its own channel. There are other ditches, for instance, the Hanapope Ditch, the Kamoola Ditch, Wilcox Ditch and several others, all of which are constructed to supply land that justified expense. On the Island of Maui are a number of similar cases as also the case on the Island of Hawaii.

These cases of inter-watershed diversions on Hawaiian Islands, I think are simply illustrate- of the application of the general principle I have mentioned. Some of the cases of transfer of water will run back for many years and some are recent. It shows again

that when water was needed and they have conditions that justify the expense, the construction is completed.

Of course operations of the U. S. Reclamation Service are matters of record, but what they are doing in Nevada in the Truckee-Carson Project involves carriage of water from one watershed to another. In fact in one of these transfers the water is taken from a stream that runs normally into one basin or sink, over into a stream or watershed which runs into another and entirely different basin or sink. That is done by authority of the U. S. Reclamation Service and in those, as in other cases, where divides have been matters that have come in connection with these enterprises, they have not been considered as a different condition and water has been carried across them as freely as across minor divides or ridges.

They have carried the water in this case just the same as
3905 they have in the case of the Strawberry project and the Gunnison Project, as previously referred. This diversion is of less importance from one standpoint *from* those above mentioned of those which are in northern Montana.

In all those cases the water has been carried across the divide wherever the conditions justified it.

In my former testimony upon the subject of inter-watershed diversions, I spoke of such diversions being made within Wyoming in vicinity of Sheridan from Tongue River for application on lands of drainage area of Powder River. It seems that there are ditches in Montana on both of those streams below the Montana-Wyoming line, that is, in Montana after these streams running from Wyoming into Montana enter the latter state and before either of them join the Yellowstone. There are also ditches in Wyoming. I ascertained those facts from county officers in Montana counties.

Other cases of inter-watershed diversions in Wyoming, in addition to those I have previously mentioned, have been proposed by officials of Wyoming, apparently without objection. Thus, State Engineer Bond of Wyoming, in the Fifth Annual Report of the Wyoming State Engineer, suggests that the deficiency in Owl Creek might be met by diversion of the North Fork of Wind River and suggests that the cost of the survey would be money well expended.

There is the suggestion in the same report, of carrying water
3906 through the divide from Boulder Lake into Big Sandy, which, while they both finally are tributaries of the Green, are entirely independent tributaries and when they reach the Green, there is no question of any deficiency of water in the Green, but there might be in either of these two streams. There are several other similar propositions leading to utilization of water which have been surveyed.

In foreign countries there are a number of other cases of inter-watershed diversions, than those I noted. It is perfectly safe to assume that wherever conditions exist, such transfers of water will be found. I might mention several that I have run across without making any research. For instance, in Island of Ceylon in the Ambonganga series, such seems to have been the case. In Professional Papers of India Engineering, Number 217, there seems to

have been an attempt to bring water from Mulpurba to Dharway-Cottom Plains carrying water across a ridge which is typical of many that they seem to have though not as important as some of those that I mentioned in my previous direct examination. Near Bombay the large reservoir, the Bhatode Tank, Professional Paper Number 184, described an unfinished project of unknown date on the Meheree River which is carried from one watershed to another. Of course the transfers between the Tigris and Euphrates have been very extensive and are of historical importance and have recently attracted more or less attention because of the re-building, as it were, of some of these ancient diversions.

There are, however, quite a good many of the ancient canals still in existence and quite a good many take water from one of these streams and carry across the country between and terminating
3907 in another. There are, as a matter of fact, canals in existence which take water from one of these streams and run it into the other. During recent developments of past few years, there have been projects running up to a good many millions of dollars, that are in course of construction and in fact some of them I believe are completed, where reports have been made by English Engineers plans have been formulated, money has been raised and construction has been started. They are not really the re-building of old canals but they are new works, which, however in some cases are pretty near the lines of old ones that have fallen into disuse, probably from the lawlessness of the locality or political considerations, but they are simply other instances illustrative of the general principle.

No doubt further research into the subject would develop information concerning large numbers of these inter-watershed diversions wherever proper conditions exist. Diversions of this kind will be found where water is needed on one side and where land is so valuable as to justify the expense. Such diversions in such cases will be made just as naturally and just as a matter of course as we know that a thirsty man will drink water.

Even assuming that ultimately, by use of waters of both Poudre and Laramie Rivers, all of lands of Greeley-Poudre Irrigation District should be reclaimed. There are other and additional lands in drainage area of South Platte River contiguous to the Greeley-Poudre Irrigation District lands and lying to the eastward with almost unlimited acreage subject to reclamation. There are, as matter of fact, equally valuable lands lying to north and further away from main stream, than lands of the Greeley-Poudre District, but which topography of country would make very expensive to bring
3908 water for reclamation from Poudre River. When lands of Greeley-Poudre Irrigation District are reclaimed, the canals may be extended just as easily and naturally as the Cache la Poudre No. 2, the Larimer and Weld and the Larimer County Ditches have been extended in years past and just as other ditches along all of streams have been extended and waters applied to more land further down the streams.

Statement made in Bulletin No. 100 of Agricultural Experiment Station of Wyoming, at Laramie, and particularly on page 87

thereof, that average date of last killing frost in spring is May 30, indicates that the date of last killing frost in spring is very much later at Laramie than at Fort Collins or Greeley. This is true by something like 4 or 6 weeks. My recollection from records kept for many years is that average date of last killing frost in spring at Fort Collins is prior to April 15. There are, of course, some years when it falls later and some earlier. I do not have the record at hand. As matter of fact, in keeping record, we had some difficulties as to defining just what was a frost, but the average date of the last killing frost in spring is at some time in earlier portion of April.

Mr. Delph E. Carpenter: Before further examination of Professor Carpenter, with permission of counsel, I would like to introduce certain exhibits into the record. I now read into record Section 2 of Article VII of the Constitution of Wyoming, which is as follows:

"Sec. 2. Board of Control. There shall be constituted a board of control, to be composed of the State Engineer and superintendents of the water divisions; which shall, under such regulations as may be prescribed by law, have the supervision of the waters of the state and of their appropriation, distribution and diversion, and of the various officers connected therewith. Its decisions to be subject to review by the courts of the state."

I now read into record Sections 724, 727, 728, 729, 730, 732, 734, 739, 741, 743, 744, 750 and 794 of Compiled Statutes of Wyoming, 1910, as follows:

Here follow, in the record in hæc verba the statutes referred with the following numbers and titles:

3910 No. 724, Water right defined;
3911 No. 727, Application for permit;
No. 728, Duty of State Engineer;
3912 No. 729, Approval of application;
No. 730, Application, how endorsed;
No. 732, Limitation of time of completing work;
No. 734, Maps to be filed;
3913 No. 739, Date of priority;
No. 741, Rights limited to use;
3914 No. 743, Reservoirs—application for—permit;
3915 No. 744, Procedure;
3916 No. 750, Priority;
No. 794, Water right claimants must appear;
3917 From First Biennial Report of State Engineer of Wyoming to Governor of that State for years 1891-92, I read as follows from page 40:

"All persons desiring to appropriate water are required, before beginning its diversion, to secure a permit for the same from the State Engineer, the method of procedure being defined in Sec. 34, Chap. 8, Session Laws of 1890. It requires the State Engineer to furnish a blank for the application, which is to be filled out by the intending appropriator and returned to his office. It is then the duty of the State Engineer to examine this application and to ascertain if it states all the facts required to determine its character

and if the proposed use is a beneficial one and not detrimental to public welfare. If it complies with these conditions, it is his duty to approve the same, fixing the limit as to the amount of the appropriation and the date when the same must be completed.

3918 On the approval of the application the appropriator must file, within six months from the date of such approval, a plat of the proposed ditch and the lands to be reclaimed, in a scale not less than two inches to the mile.

The engineer is required to refuse permits on streams where there is no unappropriated water, or where the character or location of the proposed diversions would make it detrimental to public interest. Where permits are refused the applicant has the right of appeal to the Board of Control.

* * * Under the present law the appropriator is restricted, in the permit, to the amount actually used within the time designated, and in this way all claims to the ownership of water for speculative purposes is averted."

Also as follows from page 42: "An ap-roved permit is a guaranty from the state of the following facts:

(*a*) That the engineer believes there is an adequate water supply.

(*b*) That if the conditions of the approval are complied with, no question can arise as to the date or amount of the appropriation.

(*c*) That within the period fixed for the completion of the appropriation other appropriators will not be permitted to divert and absorb the water supply, and that a limit will be placed on subsequent appropriations, thus obviating future conflicts with the owners of ditches for which there is no water."

I refer to the testimony of the witness, R. I. Meeker, submitted by the plaintiff at Laramie November 22, 1913, and reported in Volume three of the testimony in chief for the plaintiff, and particularly to the following answers given to certain questions requesting the numbers of the permits under which the Laramie Water Company's water system has been or is now being constructed and completed, which said answer giving said numbers is in words and figures as follows:

3919 "A. 8518, 8519, 8521, 8613, 10363, 10364, 10365, 1331 reservoir; 1372 reservoir; 1373 reservoir; 1883 reservoir, 2051 reservoir; 2052 reservoir; 1939 enlargement; 2113 enlargement; 2538 enlargement; 11016, 11017, 11018, 11019, 11020, 11021, and 11022, 11016 to 11022, are attached to 2538 enlargement; 2719 enlargement; 2720 enlargement.

Q. What office are these permits issued by?

A. State Engineer's office, Cheyenne, Wyoming.

Q. These do not include any filings or claims of the Laramie Water Company outside of the State of Wyoming?

A. No.

Q. They do include the permits issued by the State Engineer's office of Wyoming?

A. Yes."

For convenience in offering all these permits in evidence for purpose largely of preventing any misconception of the status of

the so-called Pioneer High Line Canal, I will introduce certified copies as follows:

First, those diverting water from the Big Laramie;

Second, those diverting water from the Little Laramie river; and

Third, those diverting water from Douglas Creek a tributary of the North Platte River, and also other permits mentioned.

The permits included in these three divisions covering all of the permits mentioned in the above testimony of Mr. Meeker.

Concerning permits issued covering appropriations granted by State of Wyoming from Big Laramie River, whereby the
3920 priorities of such works are fixed within the State of Wyoming, I offer in evidence a certified copy of permit Number 8612 for "The Lake Hattie Supply Canal" diverting water from Big Laramie river and filed in office of State Engineer of State of Wyoming on 21st of April, 1908, and duly recorded in Book 27 of Applications on page 297, and also a blue print copy of map accompanying said application, said map also being the map which accompanies Permit 1372 Res. hereinafter introduced.

(Permit and map marked Defendants' Exhibit 159.)

Mr. Carpenter: I desire the record to show that paragraph five of said application gives the sources of the proposed appropriation as "Flood waters of the Laramie River." Also that paragraph one of said applications names Z. E. Sevison as the applicant. Attention is also called to the assignment appearing on page three of the copy of the permit showing the various conveyances and assignments which apply to this and subsequent permits.

I desire the record to show that by terms of grant of permit by State Engineer, Permit 8612 filed April 21, 1908, being the first and earliest permit filed by the Lake Hattie system, said permit is limited as follows:

"Supply canal for reservoir permits numbers 1372 Res. and 1373 Res. see also permits 8613 and 1939 Enl."

Attention is called to fact that said grant of permit does not incorporate any other permit in said grant by reference or otherwise save those above specified. Attention is called to the fact that the map accompanying said permit shows only one canal, that being a ditch from the Laramie River to and terminating at Lake Hattie reservoir, said ditch being on the map designated "Lake
3921 Hattie Supply Canal," and that no reference is made upon the map to either the Pioneer or any other canal and attention is particularly called to the fact that neither by lines, figures or words is there any reference to any "Pioneer High Line Canal," but that said map indicates solely and exclusively an application to appropriate water from the Big Laramie River through said canal as an inlet to Lake Hattie Reservoir and not otherwise. Also to the fact that at no place in said application for permit or on said map, or in the grant of permit by the State Engineer is there any reference to any other or prior filing, claim, application or permit of any other survey or canal projected or completed other than the mention made of permits, 1372 Res., 1373 Res., 8613 and 1939 Enls. which will be hereafter introduced in evidence, but none of which

have any reference to any "Pioneer High Line Canal" or any other canal having location or survey line similar to "Pioneer High Line Canal" as shown on Permit 2719 Enlargement which will be next introduced in evidence.

(Application for permit and blueprint marked Defendants' Exhibit 160.)

Mr. Carpenter: Defendants offer in evidence Exhibit 160, a certified copy of application for permit and of permit for an enlargement of "Lake Hattie Supply Canal" designated in the application as "The Pioneer High Line Canal" said application having been filed in the office of the State Engineer of the State of Wyoming July 11, 1912, and duly recorded in Book 10 of Enlargements on Page 235 in the records of that office, and bearing Number "2719 Enlargement." Defendants also offer in evidence as a part of said exhibit a blueprint copy of the map accompanying the said application. The grant of permit on said application reading as follows:

"This is to certify that I have examined the foregoing application and do hereby grant the same subject to the following
3922 limitations and conditions: * * * 'Waters diverted from the Big and Little Laramie Rivers under the terms of this permit in excess of the amount covered by permit heretofore issued, must be immediately returned in equal amount to the Laramie River from the Lake Hattie Reservoir, in such manner as to in no way interfere with prior rights on the Big and Little Laramie Rivers.'

Attention is called to the fact that the grant made by this permit is specifically subjected to the terms of previous grants of permit made to Z. E. Zevison and others beginning with, and the earliest of which is Number 8612, Exhibit 159 of date April 21, 1908, and permits subsequently filed, and that the right to the use of water to this canal covered by this permit, Exhibit 160 is limited to water already appropriated by permits 8612 and subsequent thereto, and that the right to the use of water is limited to water diverted under and by virtue of the grants contained in said permits and not otherwise.

(Application for permit and blueprint copy of map marked Defendants' Exhibit 161.)

Mr. Carpenter: Defendants offer in evidence their Exhibit 161 being a certified copy of the application for permit No. 8613 for "Hattie Canal Number One" filed by Z. E. Sevison with the State Engineer of Wyoming September 11, 1908, and recorded in Book 27 of Applications on page 298, also a blueprint copy of the map accompanying said application 8613.

(Application for permit and blueprint map marked Defendants' Exhibit 162.)

Mr. Carpenter: Defendants now offer in evidence their exhibit 162 being certified copy of application for permit Number 1372 Res. By Z. E. Sevison for Lake Hattie Reservoir, filed in the
3923 office of the State Engineer of the State of Wyoming May 11, 1908, and recorded in Book 5 of Reservoirs on page 118; also a blueprint copy of the map accompanying the said application

for permit. Said exhibit also contains the grant of permit by the State Engineer.

(Application for permit and blueprint map marked Defendants' Exhibit 163.)

Mr. Carpenter: Defendants offer in evidence their exhibit 163, being a certified copy of the application for a grant of permit Number 1273 Res. for an enlargement of Lake Hattie Reservoir filed in the office of the State Engineer of the State of Wyoming by Z. E. Sevision, September 18, 1908, and recorded in Book 5 of Reservoirs on page 119, also a blueprint copy of the map accompanying the said application for permit.

(Application for permit and blueprint map marked Defendants' Exhibit 164.)

Mr. Carpenter: Defendants offer in evidence their Exhibit 164, being a certified copy of application for a grant of permit Number 1939 Enl. for the Hattie Canal (South Lateral) being a portion of the outlet of the distribution canal from Lake Hattie Reservoir, made by Z. E. Sevison and filed in the office of the State Engineer of the State of Wyoming September 18, 1908, and recorded in Book 8 of Enlargements on page 53, also a blueprint copy of the map accompanying the said application for permit.

(Application for permit and blueprint map marked Defendants' Exhibit 165.)

Mr. Carpenter: Defendants offer in evidence their exhibit 165, being application for a grant of permit Number 2113 Enl. for the enlargement of the Pioneer Canal made by Z. E. Sevison and filed in office of the State Engineer of the State of Wyoming,
3924 July 3, 1909, and recorded in Book 8 of Enlargements on page 227, also a blueprint copy of the map accompanying said application for permit.

Defendants call attention to the fact that in none of the exhibits 161 to 165 inclusive is there any reference to any "Pioneer High Line Canal" or any appropriation for such canal, or any evidence by words, figures, or lines of an intent to construct any such canal or to claim appropriations of water for the same, and,

Further that the conditions fixed by the granting of permit on Exhibit 160 on July 11, 1912 long after the commencement of this suit, absolutely limit the right of use of water through the Pioneer High Line Canal to appropriations of water, if any, made by virtue of permits Exhibits 159, 161, 162, 163, 164 and 165, and not otherwise except such other appropriations as are covered by other grants of permits which will be hereinafter offered in evidence; but in none of which is there any claim of an appropriation of water for the "Pioneer High Line Canal" or any mention thereof.

(Application for permit and blueprint map marked Defendants' Exhibit 166.)

Mr. Carpenter: For consideration of alleged appropriations from the little Laramie River by the Laramie Water Company and its predecessors in interest, the following permits will now be considered.

Defendants first offer in evidence in this behalf their Exhibit

166, being a certified copy of application for a grant of permit for diversion and appropriation of water for Lake Hattie Supply Canal Number Two, being Number 10363, and filed with State Engineer of State of Wyoming, December 5, 1910, and recorded in Book 33, of Applications on page 247; also a blueprint copy of the map accompanying the said application for permit.

Attention is called to the fact that this is the first permit issued for diversion from the Little Laramie River for filling and supplying Lake Hattie Reservoir.

3925 (Application for permit and blueprint map marked Defendants' Exhibit 167.)

Mr. Carpenter: Defendants further offer in evidence their Exhibit 167, being a certified copy of application for a grant of permit Number 2720 Enl. for the Lake Hattie Supply Canal Number Two, filed by Lyman E. Bishop with the State Engineer of the State of Wyoming on July 11, 1912, and recorded in Book 10 of Enlargements on page 236; also a blueprint copy of the map accompanying such application.

Attention is called to the fact that neither on Exhibits 166 or 167 is there any reference to the use of water from the Little Laramie river by means of the Pioneer High Line Canal, and,

Further that the plats accompanying the said applications wholly fail to indicate the intersection of the line of any such canal, with the lines of the Lake Hattie Supply Canal Number Two as indicated on the maps and accompanying and being a part of Exhibits 166 and 167, as required by statute, thereby evidencing the fact that no such canal as the Pioneer High Line Canal was considered by the Laramie Water — or its predecessors prior to or at the time of making and filing the applications contained in said exhibits 166 and 167.

(Application for permit and blueprint map marked Defendants' Exhibit 168.)

Mr. Carpenter: Defendants offer in evidence their Exhibit 168, being certified copy of application for a grant of permit Number 8518 for the Bell Supply Ditch Number One, filed in office of State Engineer of the State of Wyoming, July 19, 1908; also blueprint copy of the map accompanying the said application.

3926 (Application for permit and copy of blueprint map marked Defendants' Exhibit 169.)

Mr. Carpenter: Defendants offer in evidence their exhibit 169, being a certified copy of application for a grant of permit Number 1331 Res. for the Bell Reservoir, filed with State Engineer of the State of Wyoming, July 19, 1908; also blueprint copy of map accompanying said application.

(Application for permit and blueprint map marked Defendants' Exhibit 170.)

Mr. Carpenter: Defendants offer in evidence their exhibit 170, being certified copy of application for a grant of permit Number 8521 for the Stewart Ditch, filed with State Engineer of Wyoming June 29, 1908; also blueprint copy of map accompanying said application.

(Application for permit and blueprint map marked Defendants' Exhibit 171.)

Mr. Carpenter: Defendants further offer in evidence their exhibit 171, being certified copy of application for a grant of permit Number 1883 Res., for the Bath Reservoir, filed September 15, 1909, in office of State Engineer of the State of Wyoming.

(Application for permit and blueprint map marked Defendants' Exhibit 172.)

Mr. Carpenter: Defendents offer in evidence their exhibit 172 being a certified copy of application for a grant of permit Number 2052 Res. for the Bell Reservoir Number Three, filed in the office of the State Engineer of Wyoming December 5, 1910; also blueprint copy of the map accompanying said application.

Attention is called to the fact that in none of the applications or maps accompanying such application included within exhibits 169 to 172 inclusive is there any mention of the "Pioneer High Line Canal" or any indication to appropriate water from the Little Laramie River or otherwise for any such canal or for lands situated beneath any such canal, and further that as evidenced by Permit Number 2719 Enl., a total failure to note the points of intersection of line of said canal with lines of canals noted on any other of these exhibits is indicative of the fact that no such canal as the "Pioneer High Line Canal" was considered by the applicants for said permits at or prior to the time of making said application securing said permits.

(Application for permit and blueprint map marked De-
3927 fendants' Exhibit 173.)

Mr. Carpenter: Defendants offer in evidence their exhibit 173, being certified copy of application for a grant of permit Number 8519 for the Bell Supply Ditch Number Two diverting waters from Douglas Creek and tributaries, which said Douglas Creek is a tributary of the North Platte River, said application being filed with the State Engineer of Wyoming July 6, 1908; also blueprint copy of the map accompanying said application.

(Application for permit and blueprint map marked Defendants' Exhibit 174.)

Mr. Carpenter: Defendants offer in evidence their exhibit 174 being certified copy of application for a grant of permit Number 2538 Enl. for the Bell Supply Number Two from Douglas Creek, filed with the State Engineer of Wyoming March 7, 1912; also blueprint copy of the map accompanying said application.

(Application for permit and blueprint map marked Defendants' Exhibit 175.)

Mr. Carpenter: Defendants offer in evidence their exhibit 175 being certified copy of the application for a grant of permit Number 11,016 for the Bell Supply Ditch Number Two from Podunk
3928 Creek, a tributary of Douglas Creek, filed with the State Engineer of Wyoming March 7, 1912; also a blueprint copy of the map accompanying said application for permit, being the same map which likewise accompanied the application for permits numbers 11,017, 11,018, 11,019, 11,020, 11,021 and 11,022. And

certified copies of said last mentioned permits are not introduced for the reason that the map acompanying exhibit 175 is indicative of the appropriations made and included within the above applications including 11,016, all of said applications for grants of permits being substantially a part of Exhibit 174, permit Number 2538, Enl.

Attention is called to the fact that in none of said permits or on the maps accompanying the same, is there any reference to any "Pioneer High Line Canal" for the use of water diverted from Douglas Creek and tributaries and to be applied on lands situated on any canal to be known as the Pioneer High Line Canal.

(Application for permit and blueprint map marked Defendants' Exhibit 176.)

Mr. Carpenter: Defendants offer in evidence their Exhibit 176, being certified copy of application for a grant of permit Number 10,364 for Interstate Canal Number Two from the Big Laramie River, filed with the State Engineer of Wyoming August 30, 1909; also blueprint copy of the map accompanying said application.

(Application for permit and blueprint map marked Defendants' Exhibit 177.)

3929 Mr. Carpenter: Defendants offer in evidence their Exhibit 177 being certified copy of application for a grant of permit Number 2051 Res. for the Robertson-McConnell Reservoir, taking waters from the Big Laramie River, filed in office of State Engineer of Wyoming, October 15, 1909; also blueprint of the map accompanying the same.

(Application for permit and blueprint map marked Defendants' Exhibit 178.)

Mr. Carpenter: Defendants offer in evidence their exhibit 178, being certified copy of the application for a grant of permit Number 10,365 for the Sand Creek Diversion Canal, by the Interstate Reservoirs Construction Company, filed in office of the State Engineer of Wyoming, December 12, 1910; also a blueprint copy of the map accompanying the same.

DELPH E. CARPENTER, a witness for defendant:

In connection with testimony already offered by introduction of exhibits in this case covering permits issued to The Laramie Water Company and its predecessors, and particularly with relation to alleged claims of appropriation for a certain "Pioneer High Line Canal," in company with Professor L. G. Carpenter, I made investigation of records of offices of State Engineer at Cheyenne, Wyo., Secretary of the Board of Control for the State of Wyoming at Cheyenne, and Clerk of District Court of Laramie County, situated at Cheyenne, to ascertain what, if any, statements of claim for appropriations of water from the Big Laramie River or any of its tributaries had been made and filed with the Board of Control in the proceedings for the adjudication of priorities of water rights from the streams mentioned.

3931 Professor Carpenter, owing to a previous engagement was called away before examination was complete and hence I

was compelled to complete same by myself and thus offer this testimony. I examined records, statements of claim and transcript of evidence introduced before Board of Control in adjudication of priorities for water rights from Big Laramie River and its tributaries, and find no statement of claim filed in said proceedings in behalf of or making claims for any canal designated as the "Pioneer High Line Canal" or any other canal which might be claimed as the "Pioneer High Line Canal", but appearing under some other name. I also found that no evidence had been submitted before Board of Control in said proceedings for or in behalf of any "Pioneer High Line Canal" or any similar canal by any other name.

I likewise searched statements of claim and evidence submitted in connection with the "Pioneer Canal" and failed to find in either of those claims or the evidence submitted in support thereof, any reference to any "Pioneer High Line Canal".

I further examined proceedings had before District Court on appeal from decree given by Board of Control, and, after an examination of all of motions, appeals, statements of claim and other documents filed in said proceeding, and after a thorough examination of all evidence submitted before District Court in such proceeding, I failed wholly and absolutely to find any reference whatever to any "Pioneer High Line Canal" or statement of claim of appropriation of water for any such canal under that or any other name and failed to find any evidence introduced in support of any
3932 claim for any such canal.

I further examined all papers and evidence relating to "Pioneer Canal", and filed and produced in such proceeding, and failed to find any reference to any "Pioneer High Line Canal" in any of such papers, documents or evidence. I examined proceedings on appeal from Board of Control to District Court with proceedings reviewing decree entered by Board of Control and terminating with decree a copy of which was heretofore introduced in evidence by plaintiffs over objection, and marked Exhibit N. I made search throughout decree entered by Board of Control from which appeal was prosecuted and found no mention of a decree in behalf of any "Pioneer High Line Canal" and no mention or decree on behalf of any such canal as a part of the "Pioneer Canal" or otherwise. I made search of decree entered by District Court, Exhibit N, and failed to find any mention of said "Pioneer High Line Canal" in said decree, either as a canal diverting water from Big Laramie River or as a part of the Pioneer Canal.

I will further state that in making said search I observed that records of Office of State Engineer of Wyoming indicate that permits Nos. 11,016 to 11,022 inclusive, are a series covering the same general appropriation and therefore, in ordering certified copies of permits, did not order copies of said permits other than the first thereof, 11,016, Exhibit 175, for reason that map accompanying that permit is same map that accompanied permits Nos. 11,017 to 11,022 inclusive.

3933 **Mr. J. D. Clark:** No cross-examination.

(Defendants' Exhibit 179, decree district court Larimer County Colorado, offered in evidence.)

Mr. Carpenter: Corporate defendants offer in evidence their exhibit 179, being certified copy of decree of District Court of Larimer County, Colorado, entered in Matter of Adjudication of Priorities of Water Rights in Irrigation District No. 48, of State of Colorado, for irrigation and other beneficial uses, February 20, 1914, insofar as same concerns system of ditches and tunnel of the Greeley-Poudre Irrigation District on Laramie River in Colorado. Attention is called to fact that by provisions of said decree priorities therein awarded begin with priority Number 65, priorities numbers 1 to 64 being covered by decrees previously issued out of said court, October 11, 1906, and a previous decree.

Mr. Fred Farrar: Defendant, State of Colorado, joins in offer of Exhibit 179, subject however, to ruling of court upon objection made to introduction of decrees of Board of Control and District Court of State of Wyoming in and for Laramie County, offered in evidence by plaintiffs herein.

L. G. CARPENTER.

3933 • Cross-examination by Mr. John D. Clark:

In 1909 and 1910 I made an examinatoin of the Greeley-Poudre project including an examination of the water supply, a portion at least of which was printed and circulated. The project as I considered it did not include a proposed extension of the West Side Collection Ditch so as to include more than a small portion of the drainage area of McIntyre Creek. My conclusions as to the water supply were derived from all available records including the records of the flow of Laramie River at Woods Landing for several years at Jelm, for three years at Glendevey and on McIntyre Creek for two years and through the Skyline Ditch for five years, and my conclusions relative to the supply available from the Poudre River were drawn from records covering a much longer period of time. My conclusions as to the amount available from the Laramie River were stated as follows:

"From these records, and taking the elevation and character of the watershed into consideration, it would seem that we can consider that the watershed of the Rawah and the McIntyre can be depended on to furnish a run-off equivalent to a depth of two feet:

That the area tributary directly to the reservoir can be depended on to a depth of 1.5 feet:

And that the east side area tributary to the East Side ditch can be depended on to a depth of one foot. This would make a total—from the Upper Rawah, 12,600 acre feet; from the Lower Rawah, 10,000 acre feet; from the small streams through the Rawah ditch, 8,800 acre feet; from the East and West Laramie and tributaries to reservoir, 7,440 acre feet; from Nunn and Deadman Creeks and east tributaries to the East Side Ditch, 21,800 acre feet; or a total of 62,660 acre feet.

In addition to the above the amount from the West Laramie de-

veloped above the Skyline Ditch and not developed by that ditch, an average of about 7,500 acre feet. This is obtained by deducting from the total amount produced 20,400 acre feet, the amount diverted, which averages 13,000 acre feet. Total available from the Laramie watershed, 70,160 acre feet."

3935 My conclusions relative to the amount of water available from the Poudre River were based in part upon records of the amount of water passing down out of the district for the years 1904 to 1909 inclusive and upon my own knowledge of the river for a much longer period of time, and I concluded that there was available from the Poudre in 1904, 120,000 acre feet; in 1905, 145,880 acre feet; in 1906, 22,483 acre feet; in 1907, 130,080 acre feet; in 1908, 30,590 acre feet; and in 1909, 235,000 acre feet, making an average amount of available water 120,000 acre feet, and relative to this water I stated my conclusions as follows: "This whole 120,000 acre feet of available water cannot be diverted by the proposed means of diversion, for some of it must be lost by the fact that it comes at times when it cannot be taken into the ditch and sometimes because the quantity coming from the North Poudre may be more than can be taken down directly. But the equalizing of the Stove Prairie Reservoir will be a very material assistance and will
3936 lead to a much better development of the system of exchange and to methods for preventing the loss of much of this water. It would seem that this should be able to supply at least 60,000 acre feet on the average, and probably could be depended upon for 80,000 or 90,000 acre feet, at least, within a few years." In this report my conclusion as to the amount of water available from the several sources was as follows: from the Laramie River, 70,100 acre feet; from the Poudre River, 60,000 to 90,000 acre feet; from Dowdy Lakes, 2,990 acre feet; from Douglas Reservoir, 5,833 acre feet; and from the flood waters of Lone Tree and Crow Creeks, 3,000 to 10,000 acre feet, a total of from 142,000 to 179,000 acre feet.

3937 I am not sufficiently familiar with Lone Tree and Crow Creeks to give an estimate as to the amount of discharge of either of them. Crow Creek apparently is of considerable size, as there are a number of Wyoming adjudications some of which are for 1,000 acres or more, and aggregate 21,462 acres, and there are also a number of appropriations, but not so large nor so many, from Lone Tree Creek in Wyoming. I do not know whether the Crow Creek adjudications were adjudicated by the Territorial Court, nor whether the appropriations actually exist in fact. It is my impression that the State Engineer of Wyoming has mentioned Crow Creek as an instance where appropriations were adjudicated for lands that were not irrigated.

3938 Dale Creek is quite a stream, having a bed that is probably 15 or 20 feet wide or even more, the bridge at Virginia Dale, a few miles south of the state line, being 50 feet wide. The
3939 Wyoming appropriations from Dale Creek number 111 in the list I have, all excepting one being for less than 50 acres. There are also appropriations from it in Colorado, and it is tributary to the North Poudre, from which there are large appropriations.

The diversions in other countries and in other states has been gained from the same sources generally as my previous testimony—that is, published works and correspondence, and not from personal observation, although I have been personally familiar with some of the instances referred to in my first testimony.

3940 I have supervised in person quite a number of the stream measurements made in 1912 and 1913, at every station excepting Forrester. The discharge through the several added channels at Boswell's during the high water period of 1912 was determined by the use of a current meter, in exactly the same way as on the river itself. The larger channel was 18 feet wide and something like 4 or 5 feet deep. There were three or four discharge measurements taken of these added channels. We did not maintain a gauge rod thereafter on these separate channels as we expected to depend upon the automatic register.

3941 I had independent gauge readings made at that station as a basis for my computation of discharge. They were made when my assistants went up there. I took for the basis of this sheet, in computing the discharge record, first the record given in the State Engineer's Report, in which they have worked out the depth from week to week, correcting these heights; they corrected these heights sometime after their attention was called to it, and then got what is probably or nearly the correct height. I have previously explained the discrepancies.

3942 Corrections seem to have been made fairly well. But, of course, to convert these into quantities of cubic feet per second would require the use of the rating curve, which rating curve was formed by the State Engineer's office for the depth and the quantity under the bridge. The discrepancy, I found, was about equal to the amount we give as passing through those culverts and I assume, as shown on the chart, that the discrepancy is equal practically to the amount that went around the bridge. If the stream left the channel and the water went out gradually, would start gradually, it would probably not be shown by any sudden change in the rating curve. I have made for this particular station, two curves, one for the water where it goes entirely under the bridge and one for the points representing the flow, including that outside. In both cases regular curves are formed. A single rating curve for the stream might be spoken of as the resultant flow through the

3943 several channels. The three discharge measurements taken of the whole river, including these added channels at the time the water was flowing through them, gives us a fairly satisfactory rating curve. I would have preferred to have had more observations, but the result is far better in these cases where we have these discharges at these great depths and high quantities than could possibly come from making a rating curve without any high discharges. Whatever criticism may be made of the number of measurements, the fact is that the results are far better than could possibly be had with them left out of account, and, furthermore, they agree very satisfactorily, which is one test of the value of such a series of measurements.

3944 Three of these measurements were taken when water was going through the culverts and the amount of water going through the culverts was measured at these three times. There was evidently a fourth time when water was going through the culvert, May 29, but the amount at the culverts other than the first was not ascertained, as the others were unknown at that time. When I did discover these other culverts, I was very much surprised at the amount of water passing through them, as the flow was rapid and I was quite deceived in the depth, which was much greater than I expected.

My meter measurements at Boswell's in 1912 were made from the bridge. No particular difficulty was experienced in making these measurements at high water. We contrived a way of determining the depth and holding the meter and as the meter recorded only once in five revolutions, we had no trouble on that score. That is one of the serious difficulties with waters running quite rapidly. Meter was suspended by cord from the bridge. We attempted to obtain average velocity for each section and meter was raised and lowered so as to get the velocity for whole section.

3945 Meter swung somewhat laterally owing to pulsations of current, but that did not affect the record to any particular extent.

I made measurements either in 1906 or 1908 at Decker's, but am not positive of the year. Readings were made in that year by Mr. Decker. Mr. Decker furnished the depth for the Decker station and I think evaluated them with a previous rating table that he

3946 had. I never checked the rating table. Mr. Lamb was there during the summers of 1904 and 1905. He was a competent young man, but whether or not he had sufficient data at that station I do not know.

With regard to financial practicability of construction of reservoirs on Poudre River capable of conserving extraordinary floods, will state that they call for an expenditure that could be utilized only occasionally. It would be similar to financial proposition of people in Florida preparing to heat their houses in the same manner as those in the northern part of the United States. For years of unusually high flow in the Poudre River, conservation works, to utilize the excess waters in that stream, would have to count on carrying water over more than one year. The utilization of this water means the presence of population on the land; that population must have a living from year to year and they are not justified in going out on to the land and settling to raise a crop only once in three or four years. They must have sufficient to make a living from one year to another, and consequently the investment

3948 must be such that there can be sufficient water every year to keep these people on the land, and when water can only be conserved once in every three to five years, there must be provision for carrying over water or the people cannot live. It is a question of population as well as investment. The population has to exist and stay on the ground. From standpoint of investment, conser-

vation of flow such as extreme flow of 1884 would be im-
3949 practical to the extent that it exceeded the ordinary high year. Of such character would be the floods of 1885, 1900 and 1909, three years in thirty.

Irrigation in Poudre Valley ends latter part of September for most agricultural crops with a subsequent irrigation for gardens and fruit trees and there are various demands which take practically all water of stream during September. September is usually month of lowest flow. Supply for filling reservoirs comes from flow of October and subsequent months and floods during summer.

Practically no water is held over in reservoirs in Poudre Valley from one irrigation season to another. Referring to the printed report of the Division Engineer that on November 1, 1912, something in excess of 83,000 acre feet of water was stored in the reservoirs in the Poudre Valley, discharge records at mouth of canon
3950 for 1912, found at page 239 of Report of State Engineer for 1912, only contain in part information of flow of water in Poudre River during October and September. These records may be correct as to amount of flow at cañon mouth alone, but other factors and flows from other tributaries are to be considered.

I have no reason to doubt the record for 1912 showing that the flow of the Poudre at the mouth of the canon in September was 6345 acre feet and in October was 5059 acre feet. Without some consideration, I could not state how much water in addition to this flow in the river would be available in the Poudre Valley drainage area in those two months. The total watershed of the Poudre at the gauging station at the mouth of the canon is a little more than one thousand square miles. There are tributary to the reservoirs in the Poudre Valley several streams, including Dry Creek, which is quite a tributary to Terry Lake and Douglas Reservoir, Box Elder, which at times carries a good deal of water and was the source of the largest flood which the Poudre has ever recorded, and Fossil Creek, which at times flows a great deal of water. These are largely flood streams and the floods occur usually after heavy storms. The Box Elder heads in Wyoming, I think, and sometimes it is subject to floods when there are no local storms whatever below. Streams like Dry Creek contribute enough to be a good deal of a factor in reservoir storage. The area tributary to the watershed below the canon gauging station is quite large in square miles; for instance Box Elder watershed is probably ten or fifteen miles wide and at least thirty miles long, that being añ under-estimate. The principal supply to the Poudre from these streams comes after storms, but they afford a supply at all seasons of the year. The thunder storms which contribute to them are mostly from June to September and may be as late as the first of October, although not frequently.

There is considerable water going into reservoirs from
3951 seepage that is not counted in that passing canon mouth.

3953 Reservoirs in Poudre Valley are filled as early in season as possible. The water thus stored is depended on to irrigate sugar beets, potatoes and market gardens and last irrigation of alfalfa in some instances. Water in reservoirs is held in reserve for irrigation as needs require. In some years, during latter part of July and August, there are rain storms sufficient in quantity to give an irrigation and that relieves the necessity of calling on the reservoirs to that extent at least. It accordingly results that if they have held this water in reserve for the average dry season and a few rain storms come during August, they then have some water in store that, under the circumstances, they do not need, and this water may be carried over. Most commonly, however, they exhaust their
3954 water supply and are scant. Practically all the reservoir sites in the Poudre Valley, construction of which would be justifiable from standpoint of water supply from Poudre River alone, are already developed. Some sites now impossible might become feasible at some future time. The same law of economic necessity governs reservoir construction that causes taking of water across divides all over the world. I think the construction of one of the channel reservoirs proposed by the Greeley-Poudre system would be justified where it is to be used for storage of available water both from the Poudre and the Laramie.

Redirect examination by Mr. Fred Farrar:

3956 Report from which Mr. Clark read in cross examination in which I stated "At Woods Landing with watershed of 404 square miles, the annual run-off for a period of 11 years averages about fourteen inches. This is after taking away of the amount diverted by the Sky Line Ditch and also the amount lost by irrigation," was made in December, 1909, and January, 1910, 14 inches run-off over an area of 494 square miles would be about 300,000 acre feet. The petition shows 301,353 acre feet or in round numbers, 300,000 acre feet. To get total amount above Woods Landing, Sky Line Canal would have to be added, 13,000 acre feet per annum, and also all irrigation water consumed in valley itself. These would have to be added to 300,000 acre feet.

70,160 acre feet, estimated by me in that report to be available for the Greeley-Poudre Irrigation District from its Laramie River system of works, is the figure upon which I based my estimate this afternoon that that system would divert only 23½% of the total run-off of the Laramie River in Colorado. This is rather 23½% of the net run-off after the Sky Line Ditch diversion has been
3957 deducted. If Sky Line Ditch Diversion were included the percentage would be about 22%.

Aside from reasons which I have given why reservoir designed to catch only these rare high water flows of Poudre River are not feasible, it is a fact that no farmer would be able to anticipate the high flow and therefore could not depend at all upon water for irrigation until it reached him. If he undertook to so divert water it would become a gamble rather than a safe guide for living.

I consider Mr. Field's estimate as given in his testimony, of flow of Laramie River as being very conservative.

3957 JOHN E. FIELD, recalled.

Direct examination by Mr. Delph E. Carpenter:

In Exhibit 124 I omitted records of Sky Line Ditch and North Poudre Canal prior to year 1899, for reason that I had not discharge of North Poudre except in one case, that being year 1892. I omitted it on Sky Line for reason that I was forced to omit it on North Poudre Canal, not having records, as I said, I observed that discharge of these two canals was not very different and that, by omitting both, they would compensate. It would have led to a greater error to have included the records which I had on the Sky Line canal, than to have treated it in the manner I did.

I omitted Sky Line Canal additions to Poudre River flow for reason that they about offset North Poudre Canal diversions from Poudre River flow, during years which I have no accurate record for North Poudre.

3958 DELPH E. CARPENTER, recalled:

In searching records State Engineer's office at Cheyenne, in connection with permits made for the James Lake enterprise and Sodergreen High Line Canal, appropriation for the Northwestern Land and Iron Company, from the Big and Little Laramie Rivers, I found that appropriations of James Lake System were included in permits Nos. 8385, 8386, 8387, 8388, 8389, 1279 Reservoir, 8874, 1872 Enlargement, 1971 Enlargement, 1972 Enlargement, 2325 Enlargement, 2326 Enlargement, dates of filing being between April 29, 1908, and November 19, 1910 inclusive.

Sodergreen High Line permit 2368 was filed December 27, 1907.

Wheatland Industrial Company permit, 1681 Enlargement, was filed April 18, 1907; 8531, August 7, 1908 and 11446, September 11, 1912. I found that the Northwestern Land and Iron Company claimed under permits 10,149, 10,150, 10,423, 2,304 Enlargement and 1,962 Reservoir, between dates June 3, 1909 and June 25, 1910 inclusive.

All of above are set forth on following table this day forwarded me by State Engineer of Wyoming and which has been verified
3960 by comparison with my notes.

Permit No.	Name of Applicant.	Name of Ditch.	Date of Filing.	Date of Approval.	Date of Completion.	Standing of Permit.
8385	G. S. Speer.....	James Lake Supply.....	April 23, 1908	May 19, 1908	1912	Completed.
8386	G. S. Speer.....	James Lake Supply #1..	May 1, 1908	May 19, 1908	1912	Completed.
8387	G. S. Speer.....	James Lake Supply #2..	May 1, 1908	May 19, 1908	1912	Completed.
8388	G. S. Speer.....	James Lake Supply #3..	May 1, 1908	May 19, 1908	1912	Completed.
8389	G. S. Speer.....	James Lake Supply #4..	May 1, 1908	May 19, 1908	1912	Completed.
1279 R.	G. S. Speer.....	James Lake	Mar. 27, 1908	May 19, 1908	1912	Completed.
1872 E.	G. S. Speer.....	4-Mile Flood	Feb. 17, 1909	Feb. 20, 1909	1909	Completed.
8874	G. S. Speer.....	Oasis	May 6, 1908	May 25, 1908	1909	Completed.
1971 E.	James Lake Irr. Co.....	Bellamy	Nov. 24 1908	Nov. 25, 1908	1912	Completed.
1972 E.	James Lake Irr. Co.....	Loback	Nov. 24 1908	Nov. 25, 1908	1912	Completed.
2325 E.	James Lake Irr. Co.....	Oasis	Nov. 19, 1910	Nov. 26, 1910	1910	Completed.
2326 E.	James Lake Irr. Co.....	James No. 1.....	Nov. 19, 1910	Nov. 26, 1910	1910	Completed.
8328	Oscar Sodergreen	Sodergreen Highline....	Dec. 27, 1907	Apr. 14 1908	1910	Completed.
8531	Wheatland Industrial Company	Wheatland Industrial Co.	Aug. 7, 1908	Aug. 8, 1908	1910	Time extended to Dec. 31, 1915.
1681 E.	Wheatland Ind. Co.....	Enl. Wyo. Dev. Co. #1...	Apr. 18, 1907	Apr. 18, 1907	1910	Completed.
11446	Wheatland Ind. Co.....	J. Boyd (Blue Grass)...	Sept. 11, 1912	Sept. 12, 1912	1912	Completed.
10149	N. W. Land & Iron Co....	Outlet No. 1.....	June 3, 1909	Oct. 17, 1910	....	Extended to 1914.
10150	N. W. Land & Iron Co....	Outlet No. 2.....	June 3, 1909	Oct. 17, 1910	....	Extended to 1914.
10423	Denver-Laramie Realty Company	McDonald	June 25, 1910	Mar. 7, 1911	1911	Completed.
2304 E.	N. W. Land & Iron Co....	King Water	June 3, 1909	Oct. 17, 1910	....	Extended to 1914.
1962 R.	N. W. Land & Iron Co....	Hutton L. Res.....	June 3, 1909	Oct. 17, 1910	....	Extended to 1914.

(End of Transcript, Vol. 8, Defendants.)

The complainant offered the following evidence, in rebuttal, before Clyde M. Watts, special commissioner, commencing at Laramie, Wyoming, May 12th, 1914.

THOMAS S. PARSONS, a witness in behalf of the Complainant.

Direct examination by Mr. N. E. Corthell:

3963 Agronomist in charge of field crop and farm at University at Laramie, Wyoming, since March 1st, 1910. Raised on a farm in Wisconsin and a graduate and post-graduate of South Dakota Agricultural College. Had more or less experience with farm work since graduation; also ten years in High School
3964 agricultural work. Lived ten or eleven years in South Dakota, engaged in agricultural work. Had experience in irrigation in connection with High School at Durango, Colorado, 1904-1910. My Wyoming experience was both in dry and irrigated farming carried on at agronomy farm about two and a half miles west of Laramie, both above and below Pioneer Canal. The
3965 dry farm has the better soil. Up the river the soil becomes more gravelly, but except in a very few places not enough to do any injury, being mostly on the surface. The agronomy
3966 farm has been under irrigation twenty-two years under the Pioneer Canal. Crops of wheat, oats, rye, spelts, emmer, field peas, alfalfa, various grass crops, root crops including rutabagas, turnips, beets and potatoes have been raised, generally in experiment plats from ¼ acre up large enough to base reasonably accurate estimates of production. We have used ordinarily good farming methods in plowing, cultivation and irrigation. In especially wet
3967 years we obtained very fair crops on the dry land, notably in 1909. The next two years were very dry and the crops were rather small but produced considerable forage in oats, field peas, wheat and barley. The grain crops would not be considered paying crops, but the forage would. Rye was the best crop, averaging about ten bushels to the acre for three years, wheat and oats less. Crops were not threshed, but an estimate was made of the quantity. I don't consider dry farming profitable on the Laramie Plains unless under certain conditions where forage is raised to feed the stock. Grains cannot be raised in paying quantities by dry farming methods.

During the same years, we had good results on the irrigated farm with all grains and crops except potatoes, where the same trouble occurred as in Colorado. Oats 46-103 measured bushels,
3968 barley 30-78 bushels, winter and spring wheat 15-43 bushels, alfalfa 3-5 tons per acre. We usually plant about the first
3969 week in April and I have never seen any damage to grain from early spring frost. In 1910 frost caught some unharvested crops August 24th. In no other year has the frost injured any of our grain crops. July 31, 1913, frost injured potatoes and buckwheat, etc.; we never put out beans because we only get green beans. Have sent out each spring in 1913 and 1914 about 3,000 pounds of seed grain. Prevailing wind is from southwest, some from

the west. Wind is not as heavy during the growing season as before planting. North or northwest winds do not prevail to any extent during the summer. I have not made any personal observa-
3970 tions. The general climatic conditions are perhaps not as favorable as in some sections, but for general mixed farming there is no reason why a man should not be successful—that is, in stock raising, dairying and growing a variety of feed for stock. All crops produced are of good quality, the grasses and grains being higher in food value than those grown at lower altitudes. The crops raised have been fed to stock on the University farm.

Have observed, to some extent, the methods of irrigating which will compare favorably with the method of handling water elsewhere, especially Colorado. Have observed methods of grow-
3971 ing crops in San Luis Valley, Colorado. At first only field peas were grown. Later, they have developed higher altitude grains and they are grown in considerable quantities.

Comparing methods and results in the Laramie Plains region with those in Colorado, South Dakota and Wisconsin, I have observed that conditions are as favorable here as in most of the other sections for general mixed farming, stock raising and feeding of grains, dairying, hog raising, etc., but not for grain raising. The methods and results here have been profitable under good management such as prevails on experiment farm.

3972 Direct examination by Mr. John D. Clark:

In Durango, Colorado, I did some special observation work and other work in connection with Prof. Olin and others in preparing a small monthly for use of teachers in the Agricultural College at Fort Collins.

The agronomy farm at Laramie is very heavy clay soil on the lower bench and of a very gravelly nature. The North Canal runs through a corner of the dry farm, but none of it can be ir-
3973 rigated. The soil is much the same as the land under ditch farther up the river. Have sampled the soils each year and also some of the soils about a mile West and South in Township 15, Range 74, where the surface appearance is much the same. A little gravel on the surface, but not enough to do any harm.
3974 Observed practically no difference between the surface soil and the sub-soil to a depth of four feet. Some gravel on the surface, a little all the way down. The soil is lacking in humus but good soil for agricultural purposes. The amount of gravel contained is a benefit, making the soil easier to work. As far as I observed, the soil farther up is generally of the same character. Taken as a whole, the land is on this little gravelly order. Don't know of any place where gravel is sufficient to injure soil except a few very small areas where there are rocks and larger stones on the surface. Field peas are one of our best crops, being raised for hay or ensilage and not threshed. It is one of our hardiest crops, not easily
3975 affected by frost, high in feeding value and being one of the legumes, benefits the soil, a valuable crop for feeding purposes. Potatoes in 1910 yielded on one half acre plat at the rate of

90 bushels, being best that year on the dry land. I estimate yields at an average of 150 bushels per acre on our irrigated land. In 1911 we had no crop, due to the blight which also prevailed in Colorado and other regions. In 1912, the injury was not so extensive. In 1913, frosts on July 31st stopped the growth. The state farm
3976 records extend over twenty-two years, giving some higher yields. I think farming in connection with the raising of cattle and the dairy business would be successful in tracts of 80 to 160 acres, giving the farmer a proper living. Our methods on the agronomy farm have not been exceptional, but were adopted to demonstrate the best method of farming and successful crop raising. They need not involve any extra expense.

Cross examination by Mr. Fred Farrar:

3977 Was teacher at Durango High School. Durango vicinity one of newer sections in point of agricultural development in Colorado. Durango in former years was largely dependent upon mining as source of commercial revenues. Ute reservation in that vicinity opened in 1898 and time I was there considerable farming was being done all through that reservation and upon what was called Florida Mesa and Upper Animas Valley above Durango. Of course, considerable fruit raising was done there even at that time.

When I testified that in 1909 there was extraordinary precipitation in Laramie, Wyoming, region, I merely stated that upon impression from my talk with Mr. McWethey, my predecessor and fact that rain came down during growing season.

Upon consulting Bulletin No. 100 issued by Agricultural Experiment Station of University of Wyoming and referring to tabulation of precipitation shown on page 33, covering 20 years from 1891 to 1910, inclusive, I find that 1909 was rather below normal according to records. I have not compared records at all. It is below normal as to entire year and also during growing season. I am not able to state with certainty whether Laramie Plains area produces enough grain, wheat particularly, to supply local demand.

Do not know whether or not local mill is in operation at Laramie. I know it has been in operation a part of time during recent years. Think some of wheat they were utilizing was brought in from dry farm region east of Cheyenne, for they have an elevator there. Have no knowledge or information relative to importation of wheat to the mill. Laramie Plains area has not produced sufficient potatoes to supply local demand.

3979 In my judgment from knowledge which I have, Laramie Plains area does not produce sufficient quantity of wheat to supply local demand. This emphasises point I made, that grain raising will not pay and we do not use wheat to feed stock.

We do not claim we are a great wheat raising section although we can raise fair crops of wheat but do not class wheat as a crop in mixed farming method.

Mixed farming is raising of materials that can be fed directly to

stock. It is my idea that farming can be made successful on Laramie Plains when crops are raised that are fed locally. I encourage custom of building silos and preserving forage. Because that is best paying part of farm for dairying and stock feeding. Dairying and stock feeding are essentially necessary to success in farming in this area same as it is in any area, unless it is in some specialized area where they can raise sugar beets or something of that kind. I don't think cost of producing such crops would be any greater than in other states and recognized farming areas, especially as time comes when more land will be under cultivation and more feed will be raised in a locality and, with mixed farming, a certain amount of feed should be raised, enough to supply home demand.

3980 Experimental work which I have been conducting consists of cultivation of plats from a quarter of an acre to an acre in our experimental work. The acts require that we do that along line of variety work. These experiments are designed to secure very best possible results conditions will afford same as on any farm. The farming methods pursued in any experiment station are actually of higher type than that followed by farmer in commercial way, because we emphasize scientific side of it and are working for something more than ordinary farmer is working for. Experimental farm here certainly was not selected with care. They could not have selected a poorer piece of land in whole valley than the agronomy farm, that is the one that is irrigated. It is a very poor piece of land. I merely emphasize fact that even that land can be made to produce and if we can do it there, they can do it anywhere on other land in the valley. Plats on experiment farms are scientifically and carefully prepared. We run some fertilized plats for purposes of comparison with plats that are not fertilized. We do not

3981 practice best methods of irrigation any more than any farmer should. We practice better methods than average farmers does. That is what experiment farm is for, to teach farmers themselves better methods.

We do not expect commercial returns from experiment farm because it is an experiment and not a demonstration farm. Were we running a demonstration farm, we would get returns, we would raise varieties that would produce largest amount and sizes, but Department at Washington lays down definite laws which we shall follow in regard to our experiment work and they do not advocate demonstration work. The state has to carry on demonstration work, if it is carried on. This is strictly and purely experiment work, testing different varieties, different soil treatment and for that reason our plats are not uniform. You may go over to the station and see one plat with very large yield and one with very small yield. That would not be case with an ordinary farm. For that reason we do not expect to get returns. We would expect to receive same returns from demonstration farm that average farmer would receive. It should be higher. No higher than farmer could attain if he used same methods. That is universally true in making comparison between some crops and some varieties. Average farmer will not

do his work as carefully as experiment or demonstration farm.
3982 Returns from demonstration farm are hardly typical returns for average but would be nearer than returns from experiment farm.

I stated that a few years ago field peas were only successful crop raised in San Luis Valley in Colorado. I was there in 1906 or 1907 last time. I made trip from Alamosa west by railroad. Was not away from railroad. There has been some wheat raised in that section but I never considered it a wheat country.

Did not know that as far back as 20 or 30 years enormous quantities of wheat were raised right in section I traversed in San Luis Valley. Saw mill at Monte Vista. Don't know as fact that area extending 20 to 30 miles north of Monte Vista returns enormous yields of wheat, but it may possibly be so. Never heard of Sylvester Boys or of them raising wheat that threshed over 50 bushels per
3983 acre for a number of years. Did not traverse valley north of Monte Vista. Was not there or at Mosca or Hooper. Did not know that had been wheat producing country for 20 years. I am basing my idea on advertising of what San Luis Valley has done with field peas. Field peas are commonly grown as nurse crop or in alternate years with grain in order to secure nitrogen. Have no knowledge of that being case in San Luis Valley.

My observation of San Luis Valley in Colorado was limited to one trip on railroad from Alamosa to Creed. Did not go away from railroad on either side. Didn't pass on railroad north from Alamosa. I stated from hearsay that methods are better in San Luis Valley now and from talking with Mr. Workings of Denver, who is district manager of work, when he was here week or two ago. He spoke of good work done by agent in San Luis Valley. San
3984 Luis Valley is about 300 feet higher than Laramie Plains. General topographical situation is somewhat similar to Laramie Plains.

I have heard it stated that a large area of San Luis Valley has become water logged owing to free application of water, and that it becomes necessary to drain immense area in order to reclaim it. That will be true of any section where water is not carefully handled. It is apt to be true of any section.

Made no critical general examination of methods of irrigation used in Cache la Poudre Valley or of methods of distribution of water. Merely judged that they had shortage of water a good deal of time in that section. That is what they call shallow well section in vicinity of Ault. Good many farmers are putting down shallow wells and irrigating from wells rather than ditches in that, which is poorer irrigated section.

Center of San Luis Valley is nearly 300 miles south of Laramie. Generally speaking it is width of Colorado. Durango is not very much further south than San Luis Valley. Altitude at
3985 Durango is 6500 feet.

Imagine difference in altitude would about offset latitude in San Luis Valley. It is merely my impression that there is difference of about 500 feet in altitude and that this difference in alti-

tude compensates the 300 miles in latitude. Laramie is 7150 feet and it is my impression that altitude of San Luis Valley is 7500 feet. Average through Laramie Plains is about 7000 feet.

Do not know whether or not my conclusions on this subject are borne out by experts, it is merely my own impression.

Louis Holliday Farm is crossed by North Canal. 40 acres of this farm are under my control and direction. Know nothing at all about balance of it. The 40 acres in question is north and west and above the canal. Do not know where north corner is. Think
3986 land which I have is ½ mile or further from land under canal. Am not clear as to location of canal. Canal is on this (east) side of tract of which I have control. In going out to our tract you would cross canal. My observation of matters in that locality has been limited to 40 acres under my control. We had nothing to do with any other part of his farm. Referring to map, it is 40 acres in east portion N. W. ¼ Sec. 2, Tp. 15, N., R. 74 W.

Only have hearsay knowledge of yield of potatoes in bushels per acre, aside from potatoes on experimental farm which have come under my immediate observation. The 150 bushels per acre record to which I testified is hearsay and also from our records of former years at experiment station. I had Mr. Ausperger's state-
3987 ment for average of 150 bushels per acre on 40 acres for 1909. I could not state how large proportion of home grown potatoes are sold in stores in Laramie. Do not know of any other considerable area of potatoes. A number of men out on Little Laramie raise very good potatoes. They bring them in for me to see, but I have no knowledge of areas. They were merely showing me potatoes they had raised as a matter of pride. 40 acres raised on Blackburn Ranch in 1909 were Early Ohios. Blackburn is good place, could not say best on Laramie Plains, but they have used better methods of farming than most farmers, because they were better farmers in charge of it.

Cross-examination by Mr. Delph E. Carpenter:

Disease which affected potato crop in 1911 in Greeley vicinity and generally throughout Rocky Mountain region, including Laramie Plains region, has been designated by scientists as Rhizoctonia or Fusarium. Scientists have disagreed as to just what it is. I think Colorado men have generally agreed to call it Fusarium.

It is a form of blight, whether it is the old original form of
3988 blight as they know it in east, am not able to say.

That unfortunate disease destroyed potato crop throughout whole Wyoming section, as well as in Colorado section in that year. Also as far east as central part of Nebraska. Laramie Plains region has diseases to contend with in potato crop. We have no potato bugs. There are practically no other diseases. Year 1911 was first year that disease affected potato crop of Greeley and Wyoming districts.

It is true that diseases which effect potato crop in Greeley district might also affect potato crop in Laramie Plains district.

Cannot give date of harvest of potatoes raised on Blackburn

Ranch in 1909. Think potato harvest at agricultural college that year was probably during latter half of September, because potatoes are usually left in ground as long as possible, even after heavy
frosts have come. Have thermometer at University Station
3989 6 feet above ground and they also have ground thermometer.
Have been unable to keep one at experiment station. We are getting all records we have at university and we keep no records at experiment station except rainfall at farm. Ground thermometer has been used at University four years at least.

Have read bulletin 100 issued by Agricultural Experiment Station of Wyoming, September, 1913. I have read everything in it. I read proof on it when it was being published. Could not say whether or not table appearing on page 41 of this bulletin No. 100 ("Mete-rology for Twenty Years") table entitled "Table V. Lowest Temperatures at Laramie for Twenty Years" was computed from records taken at thermometer which is situated 6 feet above ground. I have nothing to do with taking of records. I might say that if it were taken with thermometer 6 feet above ground that would be rather an advantage because ground thermometer would naturally be warmer than one above direct radiation from soil. My impression is that records of ground thermometer would show rather
higher temperatures than records obtained at thermometer
3990 six feet above ground.

Know Mr. James F. Wilson, the observer. According to his statement lower thermometer would register lowest temperature, but that does not necessarily mean, however, that frost would be injurious because we have radiation close to ground, and I still maintain it would make it warmer than above, although I merely stated it was my impression, I know nothing about it without making observations. I am not a meteorologist and profess no learning in that regard. Mr. Wilson's report of meteor-logical summary for year 1912 at bottom of page 125 of Twenty-third Annual Report of Agricultural Experiment Station of Wyoming for 1912-13, states; "The minimum at the ground shows the lowest temperature at the ground and may register a frost which will kill some vegetation, while official record, taken six feet above, will indicate no frost."

No grain at experiment farm was caught by frost in 1912 by freezing weather that came early. Everything was harvested before frost. I am not very familiar with conditions throughout Laramie Plains that year. However, most farmers put their grain in too late. We advocate early seeding. They must seed as early as they can and there is very little chance of being caught with frost. We have
not been caught with frost in last four years, except early
3991 frost of 1910. Also early frost of July, 1913 for the potatoes,
none of the grains. If Mr. Wilson on this same page 125 of the 23rd Annual Report of Agricultural College Experiment Station of Wyoming states, "Freezing weather came on so early that much grain was caught and threshing was carried on with difficulty," I don't believe he was in a little better position to know facts in that regard than I was. He was student and was not away from

university while I was over country to considerable extent. I would not say he was wrong, but possibly he got it from hearsay.

Upon reference to the official report of the Experiment Station I find that on page 125 the language that is quoted appears. Threshing was carried on late but that does not necessarily mean to say grain was destroyed by frost. Threshing can be carried on even next summer of grain that was raised previous year. We had early snows that fall and I saw one piece of grain on experiment station that was cut after it had three snows on it and grain was not hurt. That grain was used for seed and I tested grain and it was good. Mr. Wilson was not wrong in saying that threshing was carried on late but it does not necessarily say that grain was injured by storm. Storm came September 13. We threshed grain at experiment station after that and grain was cut after that. It was quite
3992 a heavy snow. Following there was storm about September 20. Grain was matured at time first snow storm came, so it did not receive any injury.

As general thing we seed grain earlier on Experiment Station that most ranchmen do in valley. They don't seed early enough, that is something we are trying to get them to do. If grain of ranchmen, such as for example Mr. Oscar Sodergreen, were killed before maturity, I ascribe that to later seeding.

Potatoes produced on Holliday Place in 1909 were of Early Strawberry variety. They are a red potato. I know of no other potato that is very nearly like them. They are one of earliest varieties. It is a variety in itself. Agricultural College experiment station at times shows about 150 bushels of Early Ohio potatoes per acre. That is variety grown on largest scale. I think that Early Ohio potato has demonstrated itself to be best potato for Laramie
3993 Plains region. Early Ohio potatoes are planted on Laramie Plains from May 15 to last of month. Our experiments have shown we get best results by planting about that time. Early variety should be planted earlier.

Blackburn Ranch of which I spoke in connection with 1909 crop, is large ranch that has been purchased by people who are seeking to sell it to people in smaller holdings. Cropping that is done there is naturally for purpose of demonstrating, insofar as possible to those prospective purchasers, just what soil and land will produce. I do not know how they measure their grain, for example. There may be a great deal difference and variation between machine measure of a grain crop and the theoretical point measure. At any rate Blackburn people are making particular efforts to sell off this ranch in smaller tracts because smaller farms are better farms than large tracts. It is a colonist project same as you find any
3994 place. Don't know anything about prices, I never inquired. Suppose it is reasonable to presume they are trying to sell it out at a higher price than they paid for it. Presume they are trying to sell it at a profit.

Frost in spring did not injure grain planted in April. It is fact that grains, and particularly some varieties of wheat and also oats, are crops peculiarly frost resisting in their earlier stages and growth.

They are different from other plants in that regard and we only intend to grow these frost resisting crops.

Problem we have is to produce crops that are frost resisting. We do not make a business of growing sugar beets. Stock beets
3995 can be grown later in season. We plant them early part of May. Have never noticed that frost injured any root crops on farm. My observation in this regard is not very extensive. Few people here try to grow those crops. Conclusion from common experience, in regions where those crops are extensively grown, that late spring frosts destroy such crops, is not erroneous, in their locality, because altitude makes a difference. On account of drier atmosphere frosts do not have damaging effect upon any crops at this altitude that they do in lower altitude with more moisture. Severe frosts will kill crops anywhere.

My recollection is that first killing frost in Laramie Plains region is from September 1 to September 15. I do not know date
3996 of average last killing frost in spring for Laramie Station.

Average date last killing frost in spring at Agricultural College Experiment Station at Laramie is given on page 87 of Bulletin 100 of Agricultural College Experiment Station as May 30. As matter of fact if average date of last killing frost at Laramie is May 30, it would be presumed that fragile plants would on an average be killed on May 30, provided they were what we class as fragile or sub-tropical plants, such as corn, tomato-s, egg plants, but not grains or root crops or potatoes. I have had a little experience in South Dakota with all crops. As a professional agronomist, my work at Laramie Agricultural College has been first experience during my life when I have devoted my entire time to the
3997 work. This has extended only four years.

Oats is probably a little more frost resisting than barley and wheat. There is not much difference between oats and barley. Emmer and spelts are equally resisting as oats. Rye is equally resisting. Wheat probably is least frost resisting. It is a fact that certain varities of wheat, known as winter wheat, are planted and propagated under heavy freezing conditions.

Beans do not mature at Laramie Station as a rule. On account of frosts in fall. Growing season is not quite long enough for beans.

Mixed farming, as I understand term, is a system of farming including raising of hogs, dairying and raising of crops on farm that are consumed and fed directly. Mixed farming is combination of stock growing, grain or crop raising. It could be characterized as farming in connection with raising livestock. College
3998 Farm has been using field peas, which do quite well in this region, for ensilage and hay during time I have been here. In 1912 think grew about 15 acres at stock farm and probably 2 or 3 acres at experiment farm. They are grown strictly as forage crop at stock farm. In 1912 they were cured for hay. They were not used for ensilage until 1913. I consider them the best paying crop for forage and ensilage. About 2 to 4 tons is probably obtained from an acre.

Pea hay is weighed when it is hauled. It is always weighed when

hauled to stock farm. Our crops at upper farm are usually hauled to stock farm immediately after cutting. Last year grain crops were hauled down immediately after cutting, when they were in such condition they could not go into barn and be stored for hay. In such condition they would ordinarily be put in stack in field.

It has been custom to weigh alfalfa hay immediately after cutting same as with peas.

Only one crop of peas is harvested each year from the ground.

Two cuttings of alfalfa are obtained on Laramie Plains.
3999 Could not estimate acreage. Alfalfa is grown on experiment farm, Hart Ranch, Frazier Ranch, owned by Mr. Buntin at this time, south of experiment farm, and on Blackburn Ranch. These are only ranches I could mention definitely except some farms in Bosler region were seeded to alfalfa in last few years. Could not state acreage. Mr. Sodergreen has small alfalfa field. Do not think Hart Ranch alfalfa fields are typical.

The 20 acre alfalfa field on south end of experiment farm would probably be best in valley. Next to that probably fields on Blackburn Ranch. These are only fields I have visited and examined. Have never been nearer to Hart Ranch field than along road. Could not say how that field would average. Have never been on Grable or old Fischer Ranch and do not know how his alfalfa field averages.

Weights of alfalfa raised on experiment farm are obtained
4000 on hay scales at time they are hauled to barn or hauled to stock farm. In other words, crop is weighed in condition in which it would ordinarily be stacked in field or stored in barn for hay, well cured. Of course that hay is not as dry as it would be some 2 or 3 months later, if left in field in stack. Have never made experiments to ascertain how much loss there would be between that hay and similar hay taken from stack in field four months later. Could not give any knowledge on that subject except state laws make difference in weight when measuring hay in number of cubic feet per ton after it has been in stack a certain period of time. That involves not only evaporation and shrinkage but settlement as well.

This yield from the 20 acre alfalfa field in 1912 was obtained in the way I have mentioned. Same is true from similar yields from small plats at college farm. They were obtained from two
4001 cuttings of alfalfa. Have not made critical and thorough study of growing of alfalfa in the Cache la Poudre Valley.

I know three cuttings of alfalfa are annually obtained in Poudre Valley and in addition that a forage crop is obtained. We get a forage crop at Laramie after second cutting. Never obtained three cuttings at Laramie. I know that they obtain a fourth cutting of hay in Cache la Poudre Valley.

Under same conditions, I should imagine first and second cuttings of alfalfa hay in Cache la Poudre Valley would be about same as in Laramie. Growth starts earlier in Cache la Poudre Valley than at Laramie. Crop also has advantage in Poudre Valley of more heat during growing season.

It would be reasonable to presume that, in point of growth, first and second cuttings of alfalfa in Cache la Poudre Valley are as good as at Laramie. Am not aware of methods used in Cache la Poudre Valley to determine production of hay per acre. Could not state whether they weigh it at time it is ready to go to stack or ascertain actual dry contents of hay in stack during early winter.

4002 Soils of Laramie Plains region do not contain great amount of humus and are deficient in that regard. That is true of all arid region soils where irrigation has not been carried on for considerable time and crops have not been grown. At any rate that is true at Laramie. On lowest land it is rather hard to keep soil in condition so that fragile plants like sugar beets may push through soil at time of seed germination. It is not true on higher bench lands. It was true at point we had beets in 1912.

It was difficult to keep plat devoted to sugar beets in 1912 in condition so that plants could push through soil at germanation. That is true on the land that is on the level of the same bench as the experiment farm. Soil of Laramie Plains region and particularly in region of College Farm is benefited to great extent by addition of manure to soil, same as any soil would be that is lacking

4003 in humus.

Have not made critical examination of soils of Cache la Poudre Valley to ascertain comparison with Laramie Plains soil. Only know from general observation and reading. That valley has been under cultivation much longer period of time and there is consequently more humus in soil.

I know that considerable areas of new land, native, prairie sod, are being converted into farm lands in that region every year. That land is lacking in humus compared with other land that has been under cultivation for many years, just as our land is. I do not known the actual analysis, physical and chemical, of soil in two regions, but anyone who has made study of soils in general way in United States knows in general way difference between arid region soils and humid region soils. I class in general way all arid region soils as practically same. So far as formation of soils is concerned, there is a great difference between soils in arid region, but not so great so far as humus is concerned.

I have previously stated, in speaking of soils of Laramie Plains region and particularly those in connection with College Farm, as follows:

"At certain seasons of year, no plow except a deep tilling plow could puncture them" (Speaking of soils at College Farm) "and they carried a large proportion of gravel which made cultivation more difficult than it otherwise would be."

I wrote such a letter to Spaulding Tilling Machine Company of Cleveland, Ohio.

Made investigations of soils in sections 9 and 2, Tp. 15, N., R. 74, W. Soil samples have been taken on College Farm immediately west of Laramie. The two places I mentioned were places where I made investigations. Those are only places I made such investigations. Samples have been taken from all parts of experiment farm

in former years, for analysis. It so happens that both Sections 2 and 9 of which I have spoken, are located on that higher bench to north and west of Pioneer Canal area, known as bench land between Laramie River and Big Hollow.

I did not go over into Pioneer Canal area and area under outlet ditches of Lake Hattie system, that is situated south of old original line of Pioneer Canal, to ascertain soil conditions or depth of soil in that region. When I have testified in this proceeding relative to soils and my examinations of them, I have referred to my examinations on these two sections on this higher bench. I have been over soils on Experiment Station farm in casual way. Have not examined them at all. My observation of these other soils would be that observation that might be had by any person traveling over them. Such a person would have the same knowledge of soils that I have. Consider I have some knowledge of soils. Do not think agronomists are the class of professional men who are exempt from errors, but they are studying what soil will grow and engineers are studying what soil is at the time. Agronomists consider what the soil will do under proper treatment. After all they are both looking at soils. It would not be presumed that an agronomist who traveled casually through the country would have as intimate knowledge of the soil of the country as would an engineer who had made a critical analysis and examination.

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I would not assume to speak with as much knowledge of soil of Laramie Plains region as would, for example, Mr. N. P. Niel who made Soil Survey of Laramie Valley area of Wyoming for Bureau of Soils of United States Department of Agriculture in 1903. This was work of Bureau of Soils. Soil Survey is different from simply passing over and observing condition of soil. At same time must take into consideration formation and kind of soil. Do not think they take into consideration future treatment of soil for growing crops. On other hand it is fact that their principal duty is to ascertain value of these soils for agricultural purposes. They are sent out by Department of Agriculture for that purpose and that after all is object of soil survey.

4007

Soil obtained on Sections 2 and 9 was not underlaid with gravel at depth of 4 feet. There was mixed soil. There may be gravel deeper down. There is a little gravel, but not enough to do any harm. I made these examinations with an auger. This is the only auger of that character we have at the station.

It is a fact that Professor Freer of Agricultural college at Fort Collins, Mr. John E. Field, State Engineer of Colorado, Mr. E. B. House, head of Department of Engineering, Agricultural College at Fort Collins, borrowed this same auger through my courtesy during season of 1913.

As matter of fact you can only bore down about 4 feet in soil with that auger. Any sub-surface water reached by that auger would necessarily be within 4 feet of surface, if there was any water there.

4008

I did not go up into the Pioneer Canal area and further west up

toward Sodergreen Lake and in that community and try to bore down in the soil with the auger. You can find places where the auger would utterly fail to penetrate for over 4 or 6 inches. I do not know whether or not I would have universally failed in the region I mention.

There may be a very gravelly sub-soil under that entire area down to the Experiment Station Farm, in so far as I know. There is better drainage if soil is underlaid with gravel. Not so much danger of alkali. Notwithstanding that fact, there are small lakes of waste water and seepage water standing throughout that area.

4009 I never went over area lying between Laramie River and Pioneer Canal and to examine soil as exhibited in cellars and excavations. My travelling over this area has been mere travel along highways in usual manners. There have been a few farms on which I have gone for examination of crops. I made no examinations there as to depth of soil and soil conditions. Have made no special investigation of where ditch cuts through excavations. Never went out especially for purpose of making observations of such places.

As a matter of fact, my examination of soil of Laramie Plains region is confined to Sections 2 and 9 above mentioned, and College Farm immediately west of Laramie, except in general way.

Necessity of application of manures to soils is covered briefly in my report of 1912 and 1913 and published on pages 57 and 58 of Twenty-third Annual Report of Agricultural Experiment Station for University of Wyoming. That relating to manuring is as follows:

"Another application of barnyard manure was given all of the plats this year and effect is being seen in the marked improvement of the physical condition of the soil as well as in the increased yields.

4010 The past season is the first in which a plow would scour when the soil was at all wet. The soil also has less tendency to bake after irrigation. The plats have received 30 tons of manure per acre in the last three years, and another application of at least five tons per acre will be given this winter. The plats are now beginning to become more uniform."

This simply emphasizes what I said yesterday in regard to that particular soil on Experiment Farm being a heavy clay soil. It needs barnyard manure to loosen it up. Manure increases yield of plats on this tract. It would be just as beneficial on gravelly soil.

This very stiff clay soil of College Farms is located on Section 1, Tp. 15 N., R. 74 W. Soil Experts of Bureau of Soils of Department of Agriculture are entirely wrong if in their Soil Survey of Laramie area they have classed the soil on the Experiment Farm as "Laramie Sandy Loam" because I know that soil for 2 feet down is calcium sulphate, almost a cement.

There certainly are spots throughout the remainder of the Laramie Plains region that are exactly the same. Spots on lower

4011 benches are that way, on upper benches not so, they are gravelly.

Soil Map attached to report of Soil Survey of Laramie Area being

Defendants' Exhibit 154, indicates that soil on this section 1 is "Laramie Sandy Loam" but that is soil on upper bench rather than on low bench. Same map shows that majority of soil shown on exhibit is of the character designated "Laramie Sandy Loam". I would class bulk of soil on upper regions lying west of Laramie River and shown on map as that class of loam, but not so with soil on first bench near river. First and second benches are much heavier soil. This is case near Experiment Station.

Mr. Niel and his soil survey party should have made a thorough investigation of area. They were sent out by the government for that purpose. I have not been up in Plains region to ascertain whether or not soil was quite similar in various portions south and
west of station, except in general way. Have been over sec-
4012 tion and noticed surface.

A critical examination of these soils might confirm the United States Government investigation in that regard.

My examination of irrigation in Cache la Poudre Valley has been very limited. I would not assume to speak with accuracy as to methods employed throughout that region.

Professor L. G. Carpenter is considered one of best authorities on irrigation and would naturally be in position to speak with much more definiteness and certainty in that regard. It would naturally be presumed that having spent most of his years in Cache la Poudre Valley, he would know something about it. He ought to be able to tell what irrigation methods prevail in that valley.

ALPHEUS P. FAVILLE, a witness in behalf of the Complainant.

Direct examination by Mr. N. E. Corthell:

4013 Animal husbandman in charge of University Farm six years last past. Was born and raised on a farm in southern Wisconsin, and lived there all my life previously. B. S., Lawrence College, Wisconsin, 1902. Summer of 1903 I spent crop reporting for a New York firm. The next three years on a farm in southern Wisconsin. 1906-1908 I spent taking purely agricultural work at
the University of Wisconsin. In the summer of 1903 my
4014 work consisted principally of traveling up and down through the middle western states from southern Texas to four or five hundred miles north of Winnipeg, Canada, making three trips over most of that country, in the spring, summer and harvest seasons. The survey was a hurried one, and a good deal of information was gathered from conversation with farmers, reports being sent in each day. Was engaged about three months. Crops were extra-
ordinarily good that year. Have been growing and feeding
4015 crops on the University stock farm. These crops were grown under irrigation and we have fed the surplus from the agronomy farm, including some green crops for silage.

4016 We have gotten other crops from the Plains here very often. Practically all grown under irrigation. Have fed beef and dairy cattle, hogs and sheep, some of them every year since I have been here. Alfalfa, native hay, barley, spelts, silage, field

peas and rape have been fed or pastured. We have ensiled oats, peas, alfalfa and barley. We experiment with substitutes for
4017 corn. The results have been generally very satisfactory in comparison with other places. Based on this winter's feed-
4018 ing experiments with beef cows, oat silage, putting an arbitrary value of $15 per ton on alfalfa, showed a comparative value of a little over $10 per ton. Range steers fed seventy days native hay in the evening and silage in the morning showed gains of 645 pounds, as against 250 pounds for those fed on native hay alone, and placing an arbitrary value of $12 per ton on native hay and the value of 8 cents per pound on the grain, gave estimated value of $9.76 per ton for silage.

4019 Fed to lambs silage with arbitrary value of $15 per ton for alfalfa, showed an estimated value of $7.80 to $9.70 per ton. Fed to dairy cows, fifteen pounds of silage replaces eight pounds of exceptionally choice alfalfa, and is estimated to be about half as valuable. The market prices assumed were probably somewhat low in comparison with eastern prices. Corn silage in
4020 the east is estimated at a value of $3 to $4.50 per ton. Oats silage has not been looked upon favorably there, and is not regarded as practicable. I estimate four or five tons per acre of silage grain fed the past year, and I believe that for sections similarly situated, silage of this kind is going to prove very beneficial.
4021 I do not think it can be raised without irrigation. Field peas as a pasture crop for pigs give very good results, also alfalfa hay and barley. The alfalfa hay grown locally is of very fine quality and I always prefer it to hay shipped in. I regard it as practicable and profitable to produce these crops under irriga-
4022 tion farming conditions prevailing here, and commercially profitable to carry on this kind of farming. The local alfalfa compares favorably with that raised in southern Wisconsin, and the barleys here are remarkably good, the oats much superior to those raised in southern Wisconsin.

4023 Cross-examination by Mr. Fred Farrar:

Graduated from Lawrence College in 1902. Started following summer in crop reporting. Reported for A. Houseman a firm in New York. They were stock brokers and a commission house in New York. Do not know what they did with information. I was simply to give them general information and to general condition of crops. My age is 34.

4024 In making ensilage of oats some of oats were green and some of them were ripe enough to thresh. There is no usual practice with harvesting oats. It is too new. Accepted practice with all ensilage crops now is to let them get pretty well matured. Some of oats were so dry we had to use water. Ensilage is necessarily a wet food. As rule we utilize our crops before stems harden. We encourage practice of siloing crops in this region. Oats put in silo are worth more, if fed on farm, than oats that are threshed for grain. With exception of where oat field is very heavy, think

greater returns would be returned by using oats for ensilage than by threshing them for grain. We find this difficulty, if we thresh oats they don't take straw for anything. If we take oats or hay they don't eat straw readily, whereas if we put it in silo straw
4025 is all utilized. As to whether or not this practice is advisable in this district, rather than to let oats go and to thresh them for grain, depends on circumstances. You cannot lay down any hard and fast rule that will apply to all cases. Speaking of average crop, if man is running dairy and wants some succulent feed, he will find that silage will work into his rations very well, on other hand if he wants cash crop he would not think of putting his oats in silo.

We have used alfalfa. I stated that 15½ pounds of silage (oats) were used for dairy cattle. We put in a very little alfalfa with the oats, just at top of silo. Stock relished alfalfa but we had our experiment under way and could give no definite results on alfalfa silage. I am not satisfied with it. I only know that it comes out satisfactorily and stock cleaned it up. I don't know what alfalfa silage turned out. Succulent feed is valu-e to stock where they have been getting lots of dry feed. In actual practice we find
4026 succulents have value that is not shown by analysis. What I mean is if you use 2 feeds of equal value, one of them succulent and the other dry, you are apt to find that you will get better returns from succulent food. It seems to keep animal in better condition. Whether or not alfalfa is to be used for ensilage depends on how a man puts up his hay, whether there is lots of rainy weather, whether the hay is coarse stemmed, etc. If man puts up his hay in very best shape, saves all leaves, has no bad weather and has hay of fine quality, I fail to see where there would be any advantage in putting it in silo. In actual practice we find that great many farms do not properly cure their hay, many of leaves are lost. There is loss in bad weather through leaching and where stems are coarse stock are liable to leave coarser parts. Under conditions of that kind it seems to me making ensilage of alfalfa would effect a saving.

Whole plan of siloing feed is of necessity predicated upon theory that it will be fed to livestock. There is no commercial value for ensilage that I know of. It does not furnish subject of purchase or sale in any other form than livestock to which it is fed.
4027 It gives a method of securing feeding value of stems as well as seed. It is not a commercial possibility distinct and separate from feeding livestock. All sorts of crops are not utilized by farmers in their silos. In some sections of country they have experimented with fair degree of success with Russian Thistle. It is ordinarily a pest. Conditions are practically same everywhere, that is, if allowed to grow and come to seed it becomes very serious pest. It depends whether you want it for dry farm crop or not. We question whether Russian Thistle is similar in value to Sweet Clover, for instance. When I left Wisconsin Sweet Clover was classed as a noxious weed, I suppose it still is, yet under certain conditions it is considered a useful crop. It is possible Russian Thistle may be found to have certain field of usefulness. It has been made into hay,

and while I don't know that station tests have been made, private individuals have reported that stock eat the Russian Thistle hay readily. Aside from sweet clover and Russian thistle, in corn district of southern Wisconsin you will find that almost every weed that grows in corn field goes into silo, in case corn is grown for that purpose. In practice a great many different crops have been
4028 utilized at different times for silage.

We shipped alfalfa in to this station for experimental feeding because we could not secure it locally.

4030 Cross-examination by Mr. Delph E. Carpenter:

I assumed arbitrary value of $15 per ton for alfalfa hay throughout our investigations, simply as result of this class of work.

If I had assumed a value of $6.00 a ton for alfalfa hay, my other values would be proportionately decreased. In the lot of steers we fed native hay which I valued at $12 per ton, if I had used a value of $8 per ton, value of silage would be reduced 1/3.

In lambs I gave value of $9.70 per ton for silage as against $15 per ton for alfalfa. Had I assumed a value of $5 a ton for alfalfa, value per ton for silage would have been $3.26.

In fattening of lambs with alfalfa at $15 per ton, I gave value of ensilage as $7.80 per ton. If I had taken alfalfa at a value of $5 per ton my values for ensilage would have been reduced proportionately.

No attempt is being made to compare oats silage I used with corn silage of Wisconsin, for values. Corn silage is the standard
4031 silage throughout the corn belt, so in comparing another silage with it, we would compare it as we compare fattening grains with corn, simply because corn has come to be acknowledged as standard fattening grain. We compare barley and all other fattening grains with corn, that would be all comparison that would be attempted in comparing oats silage. We have made no investigation of comparative values as between corn and grain, except in this way:—Last winter we fed one lot corn and alfalfa and another lot of lambs alfalfa and silage, feeding no grain. I cannot give you exact figures on that, but, of course, alfalfa and silage lot made less gain in given time than the lot which were fed corn. We do not, as a rule, compare silage with grain crop. Silage is classed as a roughage so we compare it with other roughages rather than comparing it with concentrates. Silage is valuable as a condi-
4032 tioner. It also has a good deal of feeding value, depending largely on material which is used in making the silage. As a matter of fact, the experiments I have this day reported and values I have given have been values in which both the theoretical feeding value of the silage and its effect as a conditioner were included. By these experiments we obtain the full feeding value.

Henry is one of foremost authorities on feeding and is generally taken as quite reliable.

To take reverse of arbitrary standards fixed by me, suppose value of alfalfa in a community were taken at $5 per ton and the values

of other food fixed accordingly, to obtain value comparative with one fixed by me here today, where I used alfalfa at $15 per ton, you would have to multiply the values obtained in the other communities by three in order to arrive at a value such as I have given.

Dry matter in oats silage was 40%.

4033 It would be possible to compare our feeding results in a general way with results of other agricultural college experiment stations. Conditions in stock feeding vary so that two experiments performed in different places would show more or less variation. Results obtained in practical operation may vary one way or another from results obtained in theoretical and technical tests.

Have only been familiar with irrigation farming since I came to agricultural college at Laramie. When I declare that certain crops are profitable. I do not make that statement from comparison generally through the irrigated west, but simply from local conditions as I found them at Laramie. Also as result of tests made at agricultural college station. In general way took into consideration fixing of land values.

Returns obtained by agriculture on $10 land might be profitable, whereas like returns from $200 land would be a total failure. Value is not entirely fixed by production. You have to figure capital invested. In the ultimate the land value is finally fixed upon the net return obtained.

Further cross-examination by Mr. Fred Farrar:

Stock are occasionally fed solely on ensilage. It is possibly not as successful as it might be with mixture of feeds. The figures I have given are those on silage. The lot I first mentioned in direct examination was of beef cows and we had four in each lot. In the steer lot we had six to each lot. We had two lots altogether. Total number of steers on experiment was 12. For milk cows we simply took the same cows and reversed rations. We had three on this trial where rations were reversed at end of two weeks. We only had three cows in experiment. On experiment with lambs

4035 we had 25 in each lot and all contained in two lots. The silage experiment work was conducted during this past winter.

In my investigations for New York firm during 1903, traveled through states of Texas, Oklahoma, some in Indian Territory, Kansas, Nebraska, the Dakotas and a little in Minnesota and up through Canada. All of this travel was through grain belt region, the wheat district you might call it. It was all in a district where irrigation does not prevail.

AVEN NELSON, a witness in behalf of the Complainant.

Direct examination by Mr. N. E. Corthell:

4036 Professor of Botany at University of Wyoming some 27 years last past, excepting one year's absence. Educated at

State Normal School and Harvard University. Have traveled very extensively in connection with my work over Wyoming, and
4037 to some extent in Colorado, Idaho, Nevada and Montana. Have collected specimens of native flora for the University at all available altitudes, and have been over Wyoming a great many times in connection with my duties as Secretary of the State Board of Horticulture for the past 8 or 9 years. Have published "Key to the Rocky Mountain Flora," (Appleton), and in connection with Dr. Coulter "Complete Manual of the Botany of the Rocky Mountains;" More recently, "The Spring Flora of the Inter-Mountain States" (Ginn and Co.). The Manual is used, I think, as a text book in all of the colleges and Universities of the Rocky Mountain
4038 States, Colorado, Wyoming, Utah, Montana and to some extent in Idaho. Have observed quite extensively the effect of climate and soil on the growth of plants in the Rocky Mountain region and the variations occurring in different zones of altitude and in different soils in climatic conditions. Have observed the effect of irrigation. Have taken note of the frost conditions, length of growing season, etc. A large number of native grasses, sedges and rushes, several hundred flowering plants, altogether 1200 to 1500 different kinds of seed plants on the Laramie Plains,
4039 and the adjacent foothills. I estimate at least 100 different species of grasses grown on the Laramie Plains and the foothills and mountains adjacent. The sedges and rushes are also abundant but not so numerous. All these plants, sedges, grasses and rushes are cut for hay and pass as grasses with the average farmer. By analysis the more frequent species are found to have high food values in comparison with timothy grasses. The grasses some years do not blossom and bear fruit unless irrigated.
4040 Some of them do not head out at all except when furnished with water, when they produce an abundant crop of hay. In very few places is the growth of hay without irrigation sufficient to be worth cutting. Until recent years, the ranchmen were dependent altogether upon the native hay. It has been cut in large
4041 quantities for many years and fed to stock. This includes the sedges and rushes as well as the grasses. On most of the meadows I should think the quantity is usually increased from five to ten times by irrigation. On the uplands only pasturage grows until irrigated. I have observed the gradual development of meadows under irrigation, and the replacement of the original growth with other species as irrigation developed. Timothy is unusually well adapted to the conditions of the Laramie Plains, having originated in high altitudes. It grows near timber line in
4042 the mountains west of Laramie. Have never seen heavier timothy crops anywhere than on the Laramie Plains. The size and stand of the plants is greatly increased by irrigation. Under most conditions alfalfa is fairly successful. The grains adapted to short seasons, such as earlier varieties of oats, barley and rye products produce fair crops. Very good alfalfa is grown at as high

or higher altitudes in the Star Valley in Lincoln County,
4043 Wyoming. Practically all kinds of root crops are grown on the experiment farm here, including sugar beets, turnips parsnips, carrots and rutabagas. Potatoes usually mature, depending upon the variety and the time of planting. Late varieties will usually be caught by the frost. Very successful gardens are found throughout the valleys of the Big and Little Laramie Rivers, and in Laramie, including lettuce, radishes, carrots, parsnips, peas and string beans. Beans do not mature but reach the cooking stage very nicely. Flowers of various kinds are grown very extensively.

We select hardier varieties such as pansies, sweet peas, nas-
4044 turtiums, calendula, the shasta daisy and many others. The variety of flowers grown successfully is largely the same as in other northern latitudes to the east, say Minnesota and the Dakotas. The same is true of garden vegetables, except string beans, which do not grow to maturity and furnish seed. I have practiced as well as observed the growing of garden vegetables and flowers. At other places of greater altitude in the Platte Valley and in North Park, Colorado, I have seen grass crops, alfalfa, timothy, grains and also potatoes grown very successfully. These altitudes are ap-
4045 proximately 8000 feet in places. Indigenous plants adapt themselves to frost conditions and the higher the altitude the more frost they will endure without detriment. Even at altitudes where frosts occur every night, the effect of frost seems to be somewhat proportioned to the atmospheric pressure. The lighter the atmospheric pressure, the greater degree of frost the plant will
4046 withstand. This is true of all plants so far as I know. It happens every once in a while that potatoes on Laramie Plains are killed by frost. The early varieties of crops planted are seriously damaged by frosts not more than once in five or six or seven years. I have never kept any records of damage by frost to crops on Laramie Plains. Oats, barley and rye almost invariably mature, and usually wheat of the earlier varieties. It requires what is ordinarily called a "freeze" in contact with a "frost" to seriously damage crops. With the grains mentioned and alfalfa, two or three degrees of frost or more will do no damage, but if the temperature drops ten or twelve degrees below the freezing point, many of the crops are injured of course. About four years ago a
4047 very marked freeze occurred on August 24th, damaging some of the cereal crops considerably. The temperature for practically the whole night was twelve degrees below the ordinary freezing point. Apples on Mr. Lund's trees that apparently had suffered greatly during the freeze seemed to have recovered themselves and reached a fair state of maturity. Plants seem to mature more rapidly in the high altitudes than in low, and the seed production will take place in a shorter time, in fact, the plants seem to take the whole season afforded them, whether it be long or short.
4048 Indigenous plants adapt themselves to the length of the season. Judging from the crops grown, I think the soil on the Laramie Plains is of fair quality, mostly a sandy loam, warmer than some of the muggy soil in parts of the state. As to the profit-

ableness of farming, I know that ranchmen are raising crops and apparently finding it profitable year after year. I am refer-
4049 ring particularly to the forage crops needed for stock.

Cross-examination by Mr. Fred Farrar:

4049 I used the term "ranch" in general sense that they use it here in the west, a place upon which men grow crops and more or less stock in connection therewith. Particularly a place upon which stock is principal industry and which needs certain amount of feed to carry stock through winter. Agriculture on Laramie Plains is an incident to stock business. Do not think I could separate stock raising from agriculture. If stock raising were eliminated from Laramie Plains I would not consider the Laramie Plains an agricultural section from commercial standpoint with markets we have now accessible. I mean, we do not have population here to consume enough to make it profitable for man to grow ordinary root crops and barley and the like. I do not understand that most agricultural sections are limited in their supply to their local needs. Practice of agricultural sections is to export, but I thought you were referring to growing of garden crops and truck farms.
4050 Think certain crops might be made profitable on Laramie Plains, for instance, oats. No oats or barley are exported from Laramie Plains because there is plenty of stock to take it up. Do not think oats or barley have ever been exported from Laramie Plains.

Laramie Plains have never produced enough food stuff for human consumption to supply local demand.

I do not know whether one would want, under conditions on Laramie Plains, to grow crops for any purpose apart from its connection with stock industry; it is more profitable to do that than to grow for export. I know that in many sections of country principal business is commercial agriculture. Some of grains
4051 could be grown at profit, judging by numbers of bushels and regularity of crops grown. If you limit the Laramie Plains region to crops to which it is adapted, I consider it a region favorable to agriculture aside from stock raising.

Crops which may be grown on Laramie Plains are limited by climate. Not necessarily by soil. Every locality is limited to what it grows. It is a fact that there is an almost complete absence of trees even along streams on Laramie Plains region. Am unable to account for this fact. Have no theory upon which to account for it. Only a few miles out of Laramie cottonwoods grow and then skip again and then near the foothills streams are cottonwood bordered, and it is cottonwood bordered to north end of plains and then when you get through these hills there is a stretch of about 50 miles in about Laramie without trees. It certainly is not due to climatic conditions. What killed them off in first place I do not
4052 know because trees occur at both end of plains. Trees that have been planted have grown in City of Laramie. They are of size and development as you observe. Trees right across street

were set out in early nineties, probably ninety-two or ninety-three, and they have attained height of 50 feet and diameter of 1 foot at base. They are cottonwoods. I think that a fair growth. It is not the rapid growth you would get in lower altitudes, certainly not. The climate certainly has something to do with it, the altitude.

Atmospheric pressure determines growth in a certain measure. The optimum condition for growth is below sea level; that has been determined experimentally and otherwise.

Entire absence of trees, even along streams on Laramie Plains, is possibly due to adverse climatic condition. It may have been due to prairie fires as some have suggested, that young trees were killed out repeatedly at time in possession of Indians. It has been about 50 years since Laramie Plains were in possession of Indians.

4053 Whether or not there has been sufficient time for trees to become reseeded depends upon distribution of seeds. There are cottonwoods upstream. Cottonwoods are very prolific, but conditions for germination may not always be present. Water is one requirement for trees on Laramie Plains. If you plant your tree correctly and give it fair chance and some water it will grow. I stated that plant adapted itself and its time of maturity to climatic conditions. I am speaking of indigenous plants. I would hardly think it reasonable to believe that with exotic plants, naturally accustomed to growing season of four months could accustom itself to growing season of three months and in that time produce same amount of seed or fruit it would produce in its native condition. It seems as though natural consequence would be lessening of production, but not so for indigenous plants. We would have to use indigenous plants for comparison. Native plants tend naturally to produce same kind of seed as same plant did at lower altitude, but it may take more years to reach that condition.

4055 High altitude of Laramie Plains are naturally adapted to grasses. I think they grow more abundantly at that altitude than they do in many instances at lower altitudes, if you give them sufficient water. During some years, as I previously stated, they fail to mature seed at all for lack of water. I think it is true that, except in some favorable localities, you find a heavier sod of native grass on Laramie Plains than you find outside of plains in the mountains. Native grasses even grow luxuriantly at altitudes very much in excess of Laramie Plains. Result is that an altitude such as that of Laramie Plains naturally adapts itself to production of native hay.

Lowest temperature is registered at surface of ground, ordinarily, on still nights at stations established for recording temperatures, rather than a little above the ground. In day time temperature is higher next to ground, if air is still.

Scientific term for sedges is "Carex."

Am acquainted with Professor Elliott Bailey, formerly of Cornell University, New York. He is considered an authority on "Carex" but has not worked in the genus for a number of years.

4056 Cross-examination by Mr. Delph E. Carpenter:

I spoke of early frost prevailing throughout high altitude of Laramie Plains, singling out 1910 as particular instance. In that year frosts occurred on May 2, May 3, June 4, and June 9, and set back all crops except more hardy grains, while frost of August 25 caught even grain, so that very little of it was fit for feed although many places on Laramie Plains, it could be used for feed. I am sure that the August freeze was rather an exceptional condition.

A killing frost and the freeze I spoke of on August 25, 1910, are two entirely distinct things in my mind. A killing frost is one that would catch nasturtiums, potatoes, and things of that kind. The frost of 1910 was a freeze. It naturally froze stems through. There must be a difference in degree of frost shown in the two. I would not say that killing frosts frequently occur in the Laramie Plains in August.

Twenty-second Annual Report Laramie Experiment Station reports killing frost August 25, 1911. There was a freeze August 25, 1910. This freeze is one thing impressed on my mind. Do not remember about 1911 killing frost.

I read from page 75 of Twenty-second annual Report of Agricultural Experiment Station for University of Wyoming for years 1911-12, for meteorological summary for 1911 as follows:

"There were light frosts on the 3rd and 28th of August and a killing frost reported on the 25th, that did not affect anything more than the tender plants. Grain matured perfectly. The fall was very disagreeable and cold and soil froze up by the 15th of October."

I read from the meteorological summary for year 1912 as published in Twenty-third Annual Report of Experiment Station:

"Low temperatures prevailed throughout summer and freezing weather came on so early that much grain was caught and threshing was carried on with difficulty. Ten inches of snow fell September 13 and about a week later another storm made threshing practically impossible. By October 15th the ground was frozen so that plowing was abandoned."

The Laramie Plains is a region where frost may occur in any month in the year.

My attention has been given almost exclusively to indigenous plants of Laramie Plains, except as I have observed crops. Am botanist at Experiment Station and naturally know something of crops. Indigenous plants found in Laramie Plains district are practically same as those found over Boulder Ridge to south and at headquarters of Cache la Poudre River. Different species of course come in in different localities. On those headwaters of Cache la Poudre River, generally speaking, we expect to find same grasses, sedges and flowers and same indigenous plants as exist on Laramie Plains. I think same character of agriculture might be carried on at headwaters of Poudre as on Laramie Plains.

4059 In Cache la Poudre area plants that are indigenous to altitude of Laramie Plains are confined largely to what are called the mountain regions. Some species extend through much wider

range of altitude than other species. Plains of Cache la Poudre drainage are at much lower altitude, but you will find a considerable number of same indigenous grasses you find on Laramie Plains. These indigenous grasses as a rule, are those of quite meager growth from standpoint of annual production. On Laramie Plains, for example, it takes a number of acres of indigenous grass land to support one animal during season unless you irrigate lands, when quantity is vastly increased, in proportion to natural arid condition. I mean that several times amount is produced as would be without irrigation. The production in tons or otherwise per acre, is best known by those who own land and are familar with yield. I am not particularly advised on that subject but have heard estimates made. I never made any measurements. Never made any particular investigations.

4060 A large number of grasses and plants grow even above timber line. In neighborhood of timber line there are a great many beautiful flowers. There are a few above timber line. We find flowers even in region of perpetual snow. We certainly would not class that country as agricultural simply because we find flowers there. During summer months there are a few cattle and other animals which feed at timber line and above and live on the grasses there. Some of the so-called parks are practically meadows. Some of these parks even up at timber line yield very heavily in hay. They yield hay to much greater degree, without irrigation, than do the Laramie Plains region. I think hay production on Laramie Plains would be as abundant if as much water were furnished.

4061 Native hay is raised in Laramie Valley in Colorado from irrigation.

Grasses are a form of plant life that thrive at very high altitudes and in cold climates with short seasons and equally well where seasons are longer if you furnish them with same soil and amount of water. A greater yield in tons is expected in lower altitudes.

Alfalfa grown under short season conditions in cold climate of Laramie Plains does not produce so many tons per acre as it would in lower altitude. Tendency of plant like alfalfa is to mature a little quicker in a more rigorous climate.

Garden truck has been imported into Laramie Plains region for a great many years and still is. While garden truck is raised in some private gardens it is not cultivated on any extensive scale on Laramie Plains. Same is true of fruit, such as apples.

4062 Laramie Plains is by nature a country naturally given to low temperature and short growing seasons. Consequence is that plant life must be of character adapted to such a locality. Feeding of crops grown on Laramie Plains to livestock is about only practical and most profitable way of farming, judging from experience extending over last 40 years.

In ascertaining amount of growth on plats from standpoint of natural fertility, at experiment station, one should not overlook fact that grounds of that section have been manured. Do not have definite knowledge of soil conditions of that station and do not know whether or not plants were ever manured.

There are very few manured fields in Laramie Valley. Best potato crops which have come under my observation have been on unfertilized new land. I presume same is true in the potato producing region of the Cache la Poudre Valley.

4063 Stimulus to plant growth by irrigation is same throughout arid west as on Laramie Plains. Water is necessary ingredient in constitution of plant.

During 27 years I have been at Laramie there has been very little grain exported; most of grain has been consumed at home. If any had been exported it would be in form of grain, oats or barley. Some wheat has been grown but has been used at home.

During these 27 years, a large portion of grain consumed in valley has been imported.

AVEN NELSON.

4063 Redirect examination by Mr. Corthell:

I have frequently noted the temperatures at the University station. The observed difference between the temperature at the surface of the ground and at the standard height of six
4064 feet varies in the extreme from two to five degrees on still nights at Laramie. Referring to the testimony of Professor C. P. Gillette, concerning a species of plant lice observed by him on the Laramie Plains (the cottonwood Aphis), I have
4065 observed this species in connection with my work. Have occasionally found specimens in galls on trees in Laramie, but most generally distributed upon the leaves in the open. Have never examined the gall to determine whether there were
4066 several broods in the gall or not. That certainly is not the usual condition with plant life on cottonwood trees. Successive productions are the usual occurrence, six or seven in the course of the season. The difference occasioned by altitude would consist in the number of broods in a season. The phenomenon observed by Mr. Gillette indicates a condition in that gall abnormal for this region. The prevailing winds at Laramie are southwest to south. In the summer season they are comparatively warm. Very
4067 chilly southeast winds occur occasionally in March, April and May. Southeast and east winds are the most disagreeable. The southwest wind is warm, as compared with the east and northwest winds.

Recross-examination by Mr. Fred Farrar:

4067 Am not particularly familiar with rule commonly known as "Ferrel's Law" governing winds. I should suppose that presence of mountain ranges, particularly higher ranges to west of Laramie Plains, makes considerable modification in direction of wind throughout valley, although prevailing winds in this part of state, as I have stated, one year with another, rarely come from north, except occasionally at beginning of storm or at the clearing of storm.

4068 Southwest winds are our warmest. They are the winds that blow when dry weather may be expected, following a storm.

Winds are very prevalent on Laramie Plains. As matter of fact it blows greater portion of year.

Have not considered tabulation contained in Bulletin No. 100 of Agricultural Experiment Station of Laramie, Wyoming, entitled, "Meteorology for Twenty Years," with reference to prevailing winds.

I have before me Table 36 of Bulletin which covers years 1898 to 1912, inclusive. My conclusions that prevailing winds are from southwest is not borne out by this table. According to table southwest winds are limited to five months out of total months in those 20 years. There are ten months during this period when prevailing winds are from northwest. This does not modify my answer in least. I am not responsible for this table. These records are made by students employed at $20 per month and I do not base
4069 my testimony on records that appear here.

It is true that, with exceptions mentioned, general prevailing wind at Laramie is from west as shown by table covering 12 months for each year.

I think my observation is more apt to be accurate than observation of meteor-logist at Experiment Station. Correctness of my statement can be borne out by way our trees lean. They lean as they would if wind was from southwest to northeast.

Cross-examination by Mr. Delph E. Carpenter:

Professor Gillette of Colorado Agricultural College is recognized as a world authority on "Aphidæ." In other words he is a recognized authority on tree lice. He has written on the subject. He is rather a specialist on that subject. I am therefore the more surprised that he would have passed judgment on one gall. I evidently misunderstood the reading of counsel and would not have been so surprised had he based his record on a number of galls. I based my judgment entirely upon the fact that I thought the reading stated that in one gall this condition was observed. I misunderstood.

HENRY G. KNIGHT, a witness in behalf of the Complainant.

Direct examination by Mr. N. E. Corthell:

4071 Dean of Agricultural College and director of the Experiment Station University of Wyoming for about four years past. Previously chemist for about six years. Collegiate edu-
4072 cation University of Washington, with graduate work in the University of Chicago. Have lived in Kansas, Washington, Illinois and Wyoming. Born and raised on a farm, and during college work, spent my summers there and have been directing the farming operations since I have been director of the Experiment Station. We attempted to carry on a non-irrigated farm for two years after I was director, and a year prior, but I would consider the farm a failure. Our irrigated farming was a success along

many lines. Without irrigation we got no yield of any note, and under irrigation we got a very fair and good yield of crops. Have
4073 traveled over forty thousand miles in the last three years, principally upon the Laramie Plains, which has brought me
4074 much in contact with farming and ranching operations. Irrigated farming and ranching has been successful, some of the principal crops being native hay, alfalfa, barley, wheat, rye, oats, potatoes, field peas, etc. These crops have been raised in various places on the Laramie Plains, some of which I have observed for nine or ten years. The spring and summer frosts apparently do not affect the ordinary crops grown in the valley. Frosts that come the latter part of August do considerable damage to grains occasionally. This has occurred only once since I have been here, I think three years ago. I observed that the same frost had hit the crops in Northern Colorado from a point between Fort Collins and Longmont northward. It did considerable damage in Montana. Crops grown in this region usually mature
4075 and are usable and profitable, producing seed of excellent germination. I have a general knowledge of the soils of the Laramie Valley, having made a general study of them, and soils on the bottom land and on the mesas are generally fertile, such as in the east would be considered a wheat type of soil. Have analyzed
4076 the soils at the Experiment Farm for nitrogen and organic matter. Bulletin No. 7 Wyo. Exp. Sta. "Soils of the Agricultural Experiment Farm, by Professors E. E. Slosson and W. C. Knight," at page 16, gives the following analysis:

Potash	.53 — .64	per cent
Lime	.82 — 3.77	per cent
Phosphoric acid	.14 — .15	per cent
Humus	.16 — .25	per cent

Bulletin 82 entitled "Soil Nitrogen" by H. G. Knight and Frank Smith, on page 24, shows:

Nitrogen	.032 — .126	per cent
Organic matter	2.99 — 5.15	" "

4077 The elements here spoken of, potash, lime, phosphates and nitrogen, are elements which are liable to be deficient in agricultural soils. Iron, magnesium, etc. are usually sufficient. The figures given would indicate the following supplies in weight per acre in a depth of 6¾ inches, viz:

Potash	10,600 to	12,800	pounds
Lime	16,400 to	75,400	"
Phosphoric acid	2,800 to	3,000	"
Nitrogen	640 to	2,526	"
Humus	3,200 to	5,000	"
Organic matter	59,800 to	103,000	"

out of a total of two million pounds of soil.

In a rotation of wheat, oats, alfalfa and potatoes, covering seven years, the supply of potash would be sufficient for 20 rotations; lime sufficient for 16; and phosphorus for 14. This is potash 140
4078 years; lime 112 years, phosphorus 98 years in the top 6¾ inches of soil. In three irrigations in 1895, using 68,185 cubic feet of water per acre, 93 pounds of potash, 174.9 pounds of lime were deposited or more than would be taken out by the crops mentioned. The potash and lime, therefore, are sufficient for all time; phosphates for 98 years nitrogen would have to be added in the form of manures or organic matter. Compared with soils generally in the agricultural regions of the United States in respect to potash, phosphates and lime, would be classed as a good agricultural soil, while somewhat low in nitrogen and organic matter. There is very little difference between the native fertility of the soil over a considerable portion of the Laramie Plains. I found no gravel in lands adjoining the Experiment Farm on the mesas. I found some gravel on the sides of the hills and some of the valleys, but the valleys or river bottoms are all under irrigation and most of them are composed of the most productive soil they have. For the past twenty-two years the prevailing direction of the wind
4080 at the station has been southwest. In January, February, March, April and May that is the general direction. For June, July and August it is southeast. For September it is south, and October, November and December southwest. In May, 1913, the general direction was South, June, July, August and September, southeast; in October, southwest. There was no month when the prevailing winds were north, northwest or west. I have continued experiments or investigations at the University to determine the relative values or cost of crops grown at different altitudes, and found after analysis of a considerable number of samples of grasses of the same species of different altitudes, there was a tendency for the nitrogenous matters in plants to increase with altitude, and for the crude fibre to decrease, and for the carbo hydrates to increase with altitude, in a marked way, indicating that grasses at
4081 higher altitudes are more nutritious. We have carried on digestive experiments with native hay and alfalfa, finding the digestibility high. The report of these investigations is found in Bulletin 69, Wyo. Exp. Sta. I found that the digestibility of the second cutting of alfalfa for the total dry matter was higher than that found by Dr. Heddon of the Colorado Exp. Sta. reported in Bulletin 93.

4082 Cross-examination by Mr. Fred Farrar:

Soil analysis is not a theory which can be relied upon in giving definite idea of fertility of soil, unless taken in conjunction with other things. If you have complete soil analysis, chemical, physical and bacteriological, you can pretty well place the soil.

Physical analysis has as much to do with soil as does chemical. Presence of bacteria has a great deal to do. In arid region where very little bacteria is in soil, we must give greater weight to chemical

analysis than we would otherwise. We must give about equal weight to chemical and physical analysis of soil.

Climate controls crop production largely, it controls it however only within limits. A 50 bushel wheat soil, no matter what your climate, would only give you 50 bushels of wheat. I cannot tell number of bushels of wheat soil will produce from chemical analysis,
but I can tell what limit is. Where I use the term "50
4083 bushels of wheat" in a table I was not referring to amount of
inorganic plant food which a 50 bushel crop of wheat would take out from soil. In other words adopting an arbitrary number of bushels of wheat I have simply adopted a fair crop of wheat that would be developed from chemicals in soil.

Terms "50 bushels of oats," "3 tons of hay" or "5 tons of potatoes," are arbitrary terms, which show that if other things are equal, your soil could stand a drain of that much without taking out all the plant food, nitrogens within a certain time given.

Taking question of soil fertility on chemical analysis alone, you might find even more fertile soil, theoreticially, on top of Pike's Peak than I found in my analysis of soils which I mentioned. It is a fact that some of our mountain valleys at high altitudes are extremely fertile.

Our alkalis appear principally in form of sodium sulphate or Glauber salts, mixed in their quantities with other salts. In my table I only accounted for the potash alkali which is present. My analysis from those samples do not show other forms of alkali.

Laramie Plains is exporter of native hay. Cannot give idea of amount of native hay or alfalfa exported. Some alfalfa has been exported. Could not give amount or am not positive of any being exported since 1912 or more than once. Could not give quantity or
number of years.

4085 As a matter of fact we have been compelled to import considerable alfalfa for feeding purposes at experiment work in connection with agricultural college.

Do not know of any other agricultural products being exported.

Cannot say whether local flour mill at Laramie is in operation nor amount of grain utilized. Do not know how much of the grain is imported and do not have even an indefinite idea. Do not know whether mill operates throughout the year. Some of flour produced in mill is marketed at Laramie but could not state where else.

Fruits, garden stuff and other food stuffs are imported into Laramie Plains. Garden stuff is both imported and grown locally.

Laramie Plains region does not produce sufficient food
4086 stuffs in way of vegetables to supply local demand.

Great amount of flour is imported in to Laramie Plains region.

Other than production of sheep and cattle, Laramie Plains region does not produce sufficient amount of food necessary for human consumption to supply its own needs. It supplies sufficient sheep and cattle for its own need and for export.

Laramie Plains is quite noted as livestock country and has been for a great many years. Livestock is one of principal industries.

From first settlement it has been principal industry of the region. There is no other industry to compare with it in local importance.

High altitudes naturally produce very fine grass. Laramie Plains is blessed with very good grade of native grass.

4087 On Laramie Plains they usually get a first and second cutting of alfalfa and some pasturage.

I mentioned a frost of August 25, 1910, as being serious. I now recall a frost that cut down potato vines but did not otherwise seem to affect crops at Experiment Farm on July 31, 1913.

From memory I will state that average velocity of winds in this section is something around 13 miles an hour.

Winds blow here almost throughout full year, I think that is true at high altitudes. Wind is usually shifting somewhat. Wish you would take one thing into account when you ask that question, that higher altitudes where we are at Laramie, 7200 feet, air pressure is only about 2/3 what it is at sea level, so a 13 miles wind at 7200 feet elevation is equivalent to very much more velocity at sea level because of air pressure. In other words you do not have the air weight behind it.

4088 Nevertheless the wind does blow almost constantly and is usually shifting.

Never heard of Ferrel's Law covering subject of air currents. There is always a revolution of wind about a "low" of storm center. You will also find that there is a change of direction of wind in the Laramie Plains due to contour of mountains and higher elevations surrounding us. We may have, for example, a wind from northeast. When you get next to mountains it may change its direction altogether, which of course, does not conform to the law you speak of.

Have seen winds around 60 miles an hour but would say our average winds here run about 20 miles an hour when we are having fair blow.

4089 Temperature of winds depends upon season of year and direction from which they come. Our winds from south in summer are warm. Winds from southwest are usually warm. Our cold winds are usually from east and north. In early spring when snows lie heavily on mountains we have rather cold winds from southwest.

Fact that plants in higher altitudes are more nutritious applies to native plants and tendency is to apply to plants brought in and grown for few seasons. I should judge there are certain limits to any such statement. I would not make a sweeping assertion.

There are altitudes at which it would be impossible to raise anything and altitudes at which it would be impossible to raise anything except indigenous plants. One must put limitations upon successful cultivation of any particular plant, that is true of any altitude or of any parallel north of the equator. We cannot have tropical plants in Kansas, for example. Neither could we raise bananas in the Laramie Plains. I understand that you are not speaking of extreme but reasonable limitations of plants that might be successfully raised at lower altitudes.

It is possible that while introduced plants might be cultivated at higher altitudes with greater nutritive value, it would be accompanied by loss of volume or quantity of yield. That depends altogether upon species of plant and opportunities for growing. Plants do not yield to rapid changes. They have to be changed slowly. Corn is traveling northward at rate of 5 miles per year. They are growing corn and getting big yields now up in Michigan and Wisconsin at points to Canadian border. So with your production, it does not depend upon altitude, it depends as much upon getting plants acclimatized as anything.

Going from lower altitudes to higher altitudes has same effect as going from south to north.

Altitude at Laramie, Wyoming, figured out according to our best knowledge, is equivalent climatically to somewhere
4091 around Edmonton, Alberta, Canada.

Opportunity for growing for long seasoned plants is necessarily less, but that does not apply. As you go south you find you have not grass country and seasons are long. You have better grass countries further north. It is because at south it gets too hot. In some of states we have difficulty in getting grass started at all, some of our northern grasses, but go up in the Himalayas and there are whole nations of people living there who are growing agricultural plants. I refer you to geographical magazines. That altitude is not altogether compensated by latitude. In Thibet they have high altitude and are further north. I want to state that great many things must be taken into consideration with regard to agricultural crops. Economical conditions must be considered, as to what has caused crops to go up, which has an important bearing upon whether higher altitudes should be used or not. If you go back into history of China you will find in "King's Twenty Centuries of China" he has found in northern China farmers farming dry lands which Americans would not consider worth touching, and the Chinese have farmed them for centuries. You will find in old countries at high altitudes lands used which we would not use in this country because of climatic conditions, but they use them.

On Laramie Plains you find economical condition has been such that farmers or ranchmen, rather, could actually make more money handling stock than they could in growing crops. In fact, one acre of irrigated meadow permitted him to control anywhere from 30 to 100 acres of range lands with small amount of water and so rough broken country throughout surrounding plains is an economical proposition for them to continue at that time and so it leads to production of cattle and sheep. We had good transportation
4092 facilities. But times are changing. My idea is that need creates economy, demand or pressure.

United States Census Report for year 1910 shows rural population of Laramie Plains to be 8/10 per square mile. I cannot argue economical pressure is heavy from that population but it is from east, not from us. 8/10 of a man can't live on nine inches of rainfall per acre, that has been proved.

Records of direction of winds are based on automatic wind machine that takes record every half minute. It gives both direction and the velocity. If wind changes from one direction to the opposite direction you have no equal velocity or prevailing direction, except for those periods and they would cancel each other. If wind was in south and veered only 90 degrees during day, prevailing direction would be southeast, that is case that very seldom arises. I think it has risen two or three times in wind record. If wind velocity is different during day, mileage of greatest velocity is taken. We would consider velocity mileage and time. In other words, if we had wind of velocity of ten miles an hour for five hours from south and wind of 5 miles an hour for same length of time from east, we would compute record upon greater number of miles that wind had blown from south and would call it southeasterly wind. During day you will usually find wind will prevail in certain direction throughout certain period of day. It will vary from southwest to south and we compute it usually by visual observation from our charts for greatest mileage and time as from southwest; we consider it from south if it is from west and blows an hour and finally gets around in south we call it a south wind. It is simply computing time and mileage together. I find a few cases where it is rather difficult to tell what prevailing wind is.

4094 Do not recall having published any wind velocities in my reports. We don't publish them for reason that our records have not been complete throughout. During one year we left out something like half a year and we got out of habit of computing velocity. There is no real cause for knowing or paying attention to velocity of wind since we kept record for twenty years. There seems to be no very great change from year to year and no special reason for publishing them.

4094 Recross-examination by Mr. Delph E. Carpenter:

All wind observations I reported were recorded at station at college at Laramie. General slope of country at that point is from Laramie mountains down toward Laramie River, the slope being westerly.

Digestibility of first cutting alfalfa, dry matter, was 60.39% for Laramie and Colorado Bulletin 93 of Dr. Heddon gave Alfalfa 62.05% for total dry matter, but in this he finds that he has of crude fibre, which is ordinarily considered valueless as a food, 49.94% digestibility, while we get 44.37%. Crude protein in Wyoming alfalfa was 73.33% digestibility and Colorado alfalfa 73.54% digestibility. Nitrogen free extract which includes starches and sugars was 71.80% digested for Wyoming and 70.74% digested in Colorado alfalfa. Percentage of digestibility of dry matter means little if not taken into consideration. This all applies to first cutting of alfalfa.

Do not have the Colorado record of digestibility of second cutting of alfalfa. I only have ours.

Digestibility is determined by actual analysis of feces and analysis

of food that is eaten. First food which is eaten is analysed, a compost simply is taken and analyzed, and then the sheep, cow or animal is fed the food and the feces are saved and are analyzed and this waste matter from body of animal will show undigested food.

I assume Professor Heddon followed same method we did. We used same method he describes. In fact it is standard method for all those who are engaged in digestion work. Doctor Heddon
4096 has been making other investigations and using some other method since. The artificial digestion method is used in some laboratories but neither Doctor Heddon nor I have resorted to it. Alfalfa is bulky food and we could not get competent results unless we make it with animals.

I have enumerated principal crops of Laramie Plains. Various areas devoted to growing of various crops I have named on Big and Little Laramie Valleys in 1913 would represent slight increase over proportion of acreage used for growing of crops during various years I have been here. Average devoted to each of various crops has not increased. I do not know acreage of various crops in valley. I do not know acreage of native hay crop. I refer to valley of Laramie River in Laramie Plains region including Little Laramie River.

4097 Native hay is the great crop of Big and Little Laramie Valleys.

We occasionally have light frosts in August. The freeze of August 25, 1910 affected whole Rocky Mountain Region. Twenty-second Annual Report Wyoming Experiment Station at page 75 shows killing frost reported August 25, 1911. It also says: "Killing frost, however, did not affect anything except more tender plants. Grain matured perfectly." And I may state that is one of peculiar things about our summer frosts here, most stuff seems to recover, it does not seem to affect them, just why we are unable to determine.

When I have spoken of killing frosts for the Laramie Region I have referred only to those frosts which kill everything, grain
4098 and all. In other agricultural regions when they speak of killing frost they use the government rule, where they kill tender plants or plants that usually grow in that district. So that a frost in one district might not do the damage it will in another.

In my official report for 1912 I do not give the date of the killing frost but do report that freezing weather came on early, so that much of grain was caught and threshing was carried on with difficulty. That was condition throughout Laramie Valley and some sections of grain were caught in dough and they had difficulty with it. We had no difficulty with ours at Experiment Station but we had difficulty in threshing because of early snows and whole region here to west of us was affected in same way. Early in September they had everything frosted at Baggs, Wyoming. It is possibly true that July 31, 1913, we had one of these frosts that killed tender vegetables. We have these killing frosts occasionally. I will say they have occurred in the last four years, 1910, 1911, 1912 and 1913.

In fact experts and myself in testifying are inclined to speak of frosts in manner I have already stated, rather than of frosts that

kill everything when we speak of killing frosts. That is natural outcome of observing plant life at this place.

4099 Occasionally grains and potatoes do not reach maturity on Laramie Plains. Early potatoes are usually grown. In Spring plants can recover from frosts more readily, they are not so mature but as for accounting for it otherwise I have never tried to make an explanation. In speaking of garden crops I referred to those raised in home gardens of town.

There has been manure applied to agronomy farm past four winters, but to my knowledge before that time and from records, there were very few plats which had any manure applied to them at all. Bulletin entitled "Soil Nitrogen" of Wyoming Experiment Station gives data concerning that.

Application of manure produced very marked increase for plats, showing land needs organic matter and nitrogen. We went further and tried artificial commercial fertilizers, phosphates, potash and nitrogen on series of plats in Agronomy Farm and compared those. We tried plat with manure and are finding that soils to which artificial fertilizers alone are applied are decreasing in yield while those upon which organic matter in any form is applied, are increasing.

4100 Recross-examination by Mr. Fred Farrar:

It is true that agriculture or crop growing, outside of crops directly consumed by man, on Laramie Plains is conducted in aid of livestock business rather than livestock business being an incident of agriculture. That is true here and at other places.

Importing of agricultural products for feeding of livestock is an aid to livestock industry. It is almost impossible for me with my general idea of agriculture, to distinguish between a country where agriculture is not associated with livestock feeding and one where it is. Agriculture simply means producing food for man and, in the end, through interventions of man, either with plants or animals. I would say that agriculture is in aid of livestock industry. I am unable to disassociate livestock from agriculture on Laramie Plains. We would carry on livestock industry under the old regime without any agriculture as you try to explain.

HENRY G. KNIGHT.

Redirect examination by Mr. John D. Clark:

4102 The average annual rainfall from the records of the University is between ten and eleven inches, about five to seven inches less than in the dry farm districts in Laramie County east of Cheyenne, a little over half occurring from May to August.

4103 Recross-examination by Mr. Fred Farrar:

Records from which I testify to rainfall in Laramie Plains are those obtained from one station and at one spot only.

JAMES MCGIBBON, a witness in behalf of the Complainant.

Direct examination by Mr. John D. Clark:

4104 Ranchman on the Willow Creek and Five Mile Creek, about nine miles south of Laramie, since 1885. Have also owned farming lands right north of Fort Collins, Colorado, under the Larimer County Canal of the Water Supply and Storage
4105 Company in the Poudre Valley. Have conducted the farming operations at the latter place about ten years, and about the same time on the Wyoming ranch. At the latter place we have put in alfalfa and oats; have cut the alfalfa twice a year, and figured it out a ton to the cutting, and fed it to our own live stock. I think you can't beat it. Raised alfalfa on our land near Fort Collins
4106 and fed lambs. The alfalfa in both places is good, but we consider that produced in Wyoming worth more than that produced in Colorado, as we have more need of it along with our ranches. I think $5.00 would be about the average price in the stack in Colorado. We haven't been able to buy any here. I think the Hart Ranch sold it for $8.00 last year. The situation has everything to do with the price, there being far more range here than in
4107 Colorado. That increases the value of crops raised here. One year it was touched with frost here in September, but I don't think it hurt it any. That was the only occasion. Thirty-five bushels per acre would be about the run of oats production. We have grown them for about twelve years. They are heavier and better for feeding than the Colorado oats. Frost has never damaged them. Potatoes were the only thing that was injured by frost.
4108 We have grown them right along every year for fifteen years, three to six acres. Our experience is that a frost in August upsets the growth, but if frosts do not occur by the second week in September, they are pretty well grown. They raise something like three tons or one hundred bushels per acre. I estimate, perhaps on the average every other season, not so good as at Greeley. The frost stops the growth but does not otherwise hurt them;
4109 makes them smaller. J. W. Collins put in some alfalfa on the upper part of Five Mile Creek, which was given no attention, but remained for years, showing very well. This was at an altitude of about 7800 feet.

4110 Cross-examination by Mr. Fred Farrar:

Reason alfalfa hay is more valuable at Laramie is that there is more demand than there is supply. We need all the feed we can get. We have a good many sheep and cattle to feed here. We need more alfalfa. I had a farm in Poudre Valley ten years. I was not living there myself. I used to go down in winter and feed lambs there. My home is in Laramie and we have a ranch at Red Buttes. Temperature in Collins is warmer than at my ranch. Do not think there is much difference between temperature of my ranch and at Laramie.

411 Cross-examination by Mr. Delph E. Carpenter:

We raise Early Rose potatoes. Am not well posted on potatoes. We raise the most early varieties of potatoes. We have been harvesting potatoes second week in September.

Do not know price of alfalfa hay at Greeley, Ault and Eaton. Did not know that it had sold around Ault year after year as high as $10 to $12 per ton in stack. Have not kept track of hay market at Fort Collins by day or month. I bought my alfalfa hay
4112 there in years 1899 and 1900, 15 years ago. I know what prices were there last year but do not know for this year. Don't think they are selling any hay this year. Do not know of price of alfalfa in stack. Would not be suprised if I was informed that alfalfa hay sold at $8 to $9 per ton in stack at Fort Collins because Laramie Plains hay sold for $14 per ton for native hay and they were glad to get it. Think in fall of 1912 I sold hay at Fort Collins for $7 per ton in stack.

Alfalfa hay is measured as a rule in Fort Collins region after it has been stacked and settled for quite a while.

4113 It is measured in early winter. Sometimes alfalfa hay is cheaper in fall in Cache la Poudre Valley than it is in spring. I suppose it would hold good as a rule. Value of alfalfa hay in Cache la Poudre Valley is fixed by demand.

LEWIS J. HOLLIDAY, a witness in behalf of the Complainant.

Direct examination by Mr. John D. Clark:

4114 Have been farming 5½ miles southwest of Laramie (Sec. 10, Tp., 15, R. 74), 1910-1914, inclusive, on dry land, and in 1913 on irrigated land also. In 1910 I had 15 acres of spring rye yielding about thirty pounds to the acre; seven acres of barley, which was a total failure, growing from three to five inches high.

4115 In 1911 sixteen acres in rye, cut for hay, yielded about one-fourth of a ton to the acre. Also tried some alfalfa, the ground being in good condition. It sprouted well but a good part of it died out during the summer for lack of water and the rest of it winter-killed. Probably twenty-five plants came up the next year. One acre of garden beets yielded about 200 pounds, averaging about two inches in diameter. Three acres potatoes yielded about 1500 pounds; one acre of carrots was an entire failure, only a few coming up; one acre of rutabagas about 3½ tons to the acre, running up to four inches in diameter.

In 1912, 22 acres of rye and oats yielded about half a ton of hay per acre in two cuttings. The oats grew about six inches high.

In 1913 about 20 acres of oats yielded nothing. About one-fourth of the field grew to a height of about six inches, about one-half only three or four inches, the rest did not come up at all. Cut about five acres in which Russian thistles grew, which made a mat thick enough to rake. In 1913 two acres of sweet clover did not come up at all. About 500 pounds of seed potatoes planted
4116 on two acres yielded 37 plants, producing 1¼ pounds. These were all on unirrigated land. In 1913 I had same irri-

gated crops under the North Canal of the Lake Hattie System, just completed. First delivery of water was about July 20th. One acre of rutabagas did not come up until the water was turned on. Irrigated about August 1st. They came up pretty well but did not develop beyond a fair stand about an inch in diameter. An
4117 acre of turnips, only a few of which came up before they were irrigated. Afterwards they came up pretty well and I harvested about a ton. 20 acres of oats and peas first irrigated about July 20th, when the gophers had eaten all the pea seed before they got sprouted. Some of the oats were on high land which could not be reached with water and grew from three to eight inches high. The irrigated part grew about 24 inches high, yielding about four tons per acre green weight; put in silo. Four and a half acres of sweet clover planted in 1913 did not make any growth until irrigated, when it became a pretty good stand, 24 to 36 inches high over about half of the plat. The other half did not have any water. Thirty-one acres of alfalfa planted after a heavy rain in July did not come up until it was irrigated. The irrigated part, about 23 acres, had a very good stand and this year is getting on nicely. I bought nine acres of oats that were planted on the Stickney farm under the Pioneer Canal, which threshed out 435 bushels, exclusive of four loads hauled home without threshing. The latter fed
4118 six horses a little over six weeks. After fairly covering the cultivated land with water, I turned it on the native pasture grass that had been pretty well eaten off and gave the grass a new start and I had a second growth that was about equal to the first. This year it is fully fifty per cent higher than the grass that was not irrigated, though having no water since last September. A farmer about two miles north had in about 20 acres of oats last year without irrigation which I tried to cut but found them too short. There was practically no grain in the heads, and above the sickle there was only about four inches of stalk left. My brother had some millet on dry land that came up pretty well, but was too short to rake after it was cut with the mower. He also had in oats, sweet clover and potatoes, and mixed oats and peas, from which he got nothing and they were not harvested. On a little patch of land that had been in rye previously, he had a scattered volunteer stand which grew up pretty well and headed out. From my experience, it is not possible economically to raise crops in the Laramie Plains region without irrigation.

4119 Cross-examination by Mr. Fred Farrar:

Several of professors at University told me of great stands of sweet clover that had been raised around Laramie but in fields I have planted I have not seen a success on dry land. Sweet clover is cut for hay. In other sections it is to certain extent considered a pest. Have understood it was formerly included in noxious weed list but has been taken out. Have seen it praised quite highly as feed. Russian Thistle is considered a pest over practically all of United States where it prevails. Sweet clover is good crop for preparing

land for other crops on account of its large roots that go down considerable depth and break up and loosen soil.

Sweet Clover or Russian Thistle are not raised where anything else will grow. I am a farmer in the sense of one who tills the soil. Have been in the lumber business.

JAMES HARDMAN, a witness in behalf of the complainant.

Direct examination by Mr. N. E. Corthell:

4121 One of the original Union Colony settlers at Greeley, Colorado, in March 1871, living there in '71, '73 and '74. Came to Wyoming in the fall of '74 and have been a resident on the Laramie Plains ever since; 22 years on Sand creek, where I
4122 took up some land in '78 and I have lived there and carried on a ranching business there for 22 years, raising principally native hay and about five acres of oats. The native hay was the best crop, irrigated land yielding about a ton to a ton and a quarter an acre. The first ten years I had about 150 acres of meadow. Later on I had more, up to about 230 acres, and about 40 or 50
4123 acres irrigated pasture additional. Could not grow hay without irrigation. I raised potatoes five or six years, the first three years on bottom land, where I lost my seed. Afterwards I moved up on to higher land and raised some very good crops of potatoes; yield, 80 to 100 sacks per acre. Also raised some turnips, yielding about 15 tons to the acre. Had very good success raising oats several years, as good as I ever saw on the Poudre. The
4124 potato vines were nipped once or twice so slightly that no damage ensued. One year it froze and the potatoes near the surface were touched. They matured previous to the frost, however. A neighbor raised fine oats and one crop of fine barley and always had a fine garden for 12 or 14 years, including radishes, onions, cabbage, cauliflower, spinach and such. These crops matured.
4125 In 1898 he raised 10 rows of sugar beets, which yielded, I estimate, from observation of Colorado crops, at the rate of about 15 tons per acre. Another neighbor, Mr. Hoge, raised good crops, including wheat, yielding fully 44 bushels to the acre, which fully matured. I bought some and put it in on my place and lost it through lack of water. Hoge had some exceptional alfalfa, yielding about 3½ tons to the acre. During 1906, '7, '8, '9 and
4126 '10 I had a place in town and every summer used to go out in the country and follow the Pioneer Ditch, looking at the crops and passing through them to examine them. I visited six or eight places I suppose between Laramie and Sheep Mountain, seeing some fine crops of alfalfa, oats, potatoes, beets, turnips and garden stuff at six or eight places, including the Experiment Farm. The crops have good yields. I would say an average of 40
4127 bushels of oats per acre, three or four tons of alfalfa (in two cuttings). The altitude in my neighborhood on Sand Creek is 7250 feet. During the four years I lived at Greeley they tried to farm a good deal and failed for want of water. I was offered

the use of land if I would put a crop in. On the tract near
4128 the residence of N. C. Meeker, I raised a nice crop of potatoes, some corn, cabbage, cauliflower and a few onions and radishes; some wheat was planted which was a failure for want of water. In '72 they got water through No. 3 ditch but not enough, and it washed out once or twice playing havoc with the crops. One man raised 44 bushels of wheat to the acre that year. As a general thing the yield was not very good. In '73 crops as a rule were good, and would have been good in '74 if the grasshoppers had stayed
4129 away. They destroyed the crops with the exception of those of a few parties in one locality. Since 1874 I have been in the Poudre Valley at different times each two or three years observing the crops grown.

In 1871 or 1872 potatoes yielded 80 to 100 sacks, which was about the general yield in that neighborhood at that time, and until they began to turn the alfalfa under when the yield began to rise with most of the crops. They had been sowing wheat so often that
4130 they got down as low as 15 bushels to the acre; when they turned the alfalfa under it began to go up and I have seen as high as seventy bushels to the acre. Wheat is rather too recent here to run the risk, but oats come up pretty close to the Greeley crop. Alfalfa about a ton to the acre less than at Fort Collins or Greeley. Potatoes do not yield so much here as there, but they are very little different from what they were there before the alfalfa was turned under.

4130 Cross-examination by Mr. Fred Farrar:

I consider wheat a risky crop on Laramie Plains because wheat is a much slower growth and requires longer season.

4131 Cross-examination by Mr. Delph E. Carpenter:

In determining tonnage of alfalfa on Hoge Ranch we measured stack and computed tonnage by assuming 422 cubic feet to the ton. I would be somewhat surprised if I knew that Mr. Hoge had frequently stated that he averaged two tons of alfalfa per acre for the season. Have seen alfalfa that think would cut more than that on that ranch.

Have not been up along Pioneer Canal this year.

Raised Early Rose and Early Ohio potatoes on my place. Harvested potatoes October 1, depending on season.

Do not remember acreage Mr. Hodge had in alfalfa. Have traveled over Cache la Poudre Valley from La Porte to Delta. Was down there in '76, '80, '86, 1900 and 1903. In 1900 was
4132 down there on a visit for a week or two. Am 77 years of age. Did not go out and measure crops in Poudre Valley but knew people and found out by asking and found that my guess was not far from wrong. Inquired from Mr. Goetz and Mr. Moore who is now dead. He was farming in 1872. He started in
4133 with Greeley colony. Refer to Squire Moore. He lived and died at Greeley. He died there several years ago. Also knew other men who lived at Greeley.

W. P. SCHOTT, a witness in behalf of the Complainant.

Direct examination by Mr. N. E. Corthell:

4134 I have lived for four years on the John A. Fischer place about 17½ miles southwest of Laramie near the Big Laramie River and under the Fischer Ditch. Previously lived in Nuckolls County, Nebraska, about 15 years, and for 36 years (all my life before that in Pennsylvania on a farm. Have grown oats, potatoes, alfalfa and prairie hay in Wyoming under ditch.
4135 and when I had water I had good crops, better than I have ever raised any place else, which matured and yielded well,—about 45 bushels of oats per acre, maching measure, weigh-
4136 ing 43 to 48 pounds to the bushel. Potatoes about 100 bushels per acre matured and of fine quality. About two tons of alfalfa per acre and about one ton of native hay per acre. Had difficulty in getting water two years out of four, the gates being
4137 closed down by the Water Commissioner upon complaint of the Wheatland project, in consequence of which I lost about 3000 bushels of oats in 1913.

In 1912 we had water and got good crops. In 1911 the Water Commissioner closed down my gate for Hans Olson, when we were going to use the water for oats and we did not get much of a yield.
In 1910 I was a green man, the water was low, and I did
4138 not get much and did not understand how to apply it, but we got good hay. In Nebraska I farmed 200 acres of wheat and 200 acres of corn every year, and also raised potatoes. In Pennsylvania I raised clover, timothy, corn, oats, wheat and potatoes. In Wyoming the grain berries are larger and better and better filled than they are in either Pennsylvania or Nebraska, and the quantity was better. Nebraska was poor on account of lack
4139 of moisture. Potatoes also are better, both in quantity and quality. From my experience I believe it is practicable to raise cultivating crops under irrigation in Wyoming successfully from a farmer's standpoint.

In 1913 I had Section 8 and the North half of Section 21, Tp. 14, R. 74. On Section 12 there was a little alfalfa but it was pastured and run out. Last year I had oats on Section 21 and a few potatoes; 20 acres of oats yielded 50 bushels. In Section 8
4140 I had oats but only got about three acres irrigated. In Pennsylvania the oats raised weighed close to 32 pounds per bushel, in Nebraska 19 to 32 pounds. Last year in Section 21, for lack of water, we got only five or six tons of hay. In other years we got three or four big stacks from about 30 acres.

4141 Cross-examination by Mr. Delph E. Carpenter:

Raised a red potato, suppose they were Early Ohios.
Water turned off Fischer Ditch during forepart of July, 1913.
We obtain two tons per acre from two cuttings of alfalfa during each season. Alfalfa I raised was on what is known as Harley

Grable place. It is one of the good alfalfa fields of the valley. There is better alfalfa at Heart Ranch.

Alfalfa hay at Heart Ranch is better than alfalfa hay at Harley Grable Ranch. Alfalfa at Heart Ranch is newer sod. Alfalfa at Grable Ranch has been sewed for 15 to 20 years I understand.

R. I. MEEKER.

Direct examination by Mr. N. E. Corthell:

4142 I heard the testimony given by John E. Field, at Denver in relation to waste of water on Laramie Plains and recall roughly his testimony on that subject, applying to the area lying along the Pioneer Canal from a point South of Lake Hattie Reservoir to a point near Fraser's Ranch, taking in also the area in the neighborhood of the Soda Lakes, and the area to the North of the Pioneer Canal as well as to the south. Since this testimony, I have examined anew this section of country with this testimony especially in view. I was also over that neighborhood at different times in 1912, 1913 and 1914 and became reasonably familiar with it. A recent examination of this area shows 261 acres of
4143 seeped waste land. That land is pretty well saturated with water and has alkali on it, produced no plant of value for stock feeding; should be classed as thoroughly waste; of the general character described by Mr. Field, except that he went a little further and said that it was practically barren. It supports alkali weeds and very small vegetation of no value.

I also heard Mr. Field's testimony in regard to similar areas in the vicinity of the Bath and Alsop Lakes and the Little Laramie Valley, and have since made a particular examination of that region. Excluding land in the big basin not now covered but later in the season covered with water, I would say that in the vicinity of the Bath and Alsop ranches and through that portion of the country there is not to exceed 50 acres of seeped waste land. This region was examined on the 18th of May and the area under the Pioneer Canal on April 16th. Since Mr. Field's testimony, I have made a trip through the Poudre Valley in Colorado on April 20, 21,
4144 22 and 23 by automobile for the purpose of examining the irrigation and farming conditions in that valley, and also the areas of seeped waste land and water surfaces, etc. I took note and platted on topographic sheets the larger areas encountered of seeped waste lands, amounting to 1441 acres. I covered approximately 100,000 acres, about one-third of the irrigated lands in that valley. The seeped areas are very similar to those found on the Laramie Plains. I also examined the irrigation works, dams, headgates, reservoir embankments, etc. in the Poudre Valley, and made
4145 photographs. The notations or descriptions on the back of these photographs show when they were taken and describe the objects shown. The protographs were taken with the idea of getting some of the best classes of structures and also some of the inter-

mediate and poorer classes. They show also some of the seeped areas referred to and are fair representations of their subjects.

Photographs introduced in evidence and marked Defendants' Exhibit Q. 1 to Q. 20 inclusive.

4146 Exhibit Q. 20 shows Pile Division Dam of Box Elder Ditch on Poudre River below Fort Collins. It is in very poor shape, portions having washed out and some drift collected. The ditch when examined was not in use but showed evidence of having water flowing through it this year. It is a moderate sized ditch about eight feet on the bottom, carrying about 30 second feet. Name taken from Fort Collins Quadrangle Topographic Sheet of U. S. G. S. Headgate north of quarter section corner of Section 20, Township 7, Range 68. This dam is a poorer dam than those
4147 of similar size on the Big Laramie River in Wyoming, though originally a very good dam. A little increase in elevation would turn water into the ditch.

Exhibit Q 19 shows Rock Diversion Dam of the Ames Ditch at the city limits of Fort Collins, a temporary dam repaired
4148 from time to time after washing out. The ditch is one of the smaller ditches, three or four feet wide on the bottom. Dam would not be effective or efficient at low stages.

Exhibit Q 18 is a log crib and loose rock diversion dam for the Canon Ditch, located a short distance above the Poudre Valley Canal, a small ditch of a few second feet capacity. A semi-permanent dam, probably washed out occasionally by high water, and there are similar dams in Wyoming on the Laramie River.

Exhibit Q 17 is a log and loose rock diversion dam of the Greeley Municipal Water Supply, one of medium size, occasionally
4149 washed out and repaired from time to time as shown by piles of loose rock on the river bank, etc. Unless repairs are made from time to time, it would gradually lose its efficiency. At low stages the flow of the river is greater than the needs of the Greeley supply, so there will always be an excess of water there. There is always water wasting over this dam, required by other ditches below.

Exhibit Q 16 shows a log crib and rock-filled diversion dam and head works of the Poudre Valley Canal, located farthest up the canon of any of the ditches that supply the valley. This is one of the largest canals in the valley. The dam formerly extended directly across the river from the head-works, but portions have been washed out and a wing dam has been constructed, a semi-permanent structure subject to destruction in portions by heavy floods.
4150 The dam is efficient for its purpose as the diversion is one of the junior rights and a large amount of water must of necessity pass over the dam at times. There are similar dams on the Laramie River, i. e., Tunnel Diversion Dam of the Wheatland Project. The headworks are a fair type of construction, consisting of concrete abutments with wooden gates. It represents the intermediate class of structures, the best type being concrete and the poorer type loose rock dams with brush and logs. These three classes also prevail on the Big Laramie River in Wyoming.

Exhibit Q 15 shows wood diversion dam and headgates of Colony No. 3 Canal above Greeley, one of the oldest on the river.
4151 Most of the appropriations occur above this dam, which is of the intermediate class, and fairly permanent for a wood dam. The headworks shown in the foreground are constructed of wood piles, no concrete, and with wooden gates. A new concrete flume just below the headworks was put in this spring. The canal is intermediate in size.

Exhibit Q 11 shows the waste and stop gates of the Arthur Ditch above Fort Collins, in Section 3, Township 7, Range 69. It
4152 is a pioneer headgate constructed of piles and wood and was in fair repair. There are very similar structures both on the Big and Little Laramie Rivers. This is one of the smaller ditches carrying probably in excess of 25 second feet.

Exhibit Q 14 is a board diversion dam of the Arthur Ditch above Fort Collins. Would be classed as intermediate in type and represents some of the earlier practice in construction of diversion dams on the Poudre River, and is of a better type than a great many on the Big Laramie River in Wyoming.

4153 Exhibit Q 13 shows headgates of Spring Creek Ditch below Fort Collins, one of the older types of construction with wooden headgates dam. It is of the intermediate type of diversion works and serves a large canal 12 or 15 feet on the bottom. There is There is no concrete construction.

Exhibit Q 12 shows concrete and wooden headgates of Arthur Ditch, one of the intermediate type but with concrete abutments.

4154 Exhibit Q 10 is a joint concrete diversion dam of the Larimer and Weld Ditch, and the Larimer County No. 2 and the New Mercer Canals, an example of the more recent type of construction on the Poudre. All are large ditches, being the three principal ditches diverting water from the Poudre River, and representing the best type of construction found on the Poudre. The Pioneer dam on the Big Laramie River in Wyoming is directly comparable with that. The diversion dam of the Weatland Canal No. 2 on Sybille Creek is a similar type. Sacks of gravel on top of the concrete dam are shown in the picture, being a temporary experient used to increase the elevation of water in front of the headgate.

Exhibit Q 9 shows the concrete diversion dam of Larimer County Canal and Water Supply and Storage Company on the Poudre River. This is of the best type of construction, namely, concrete.

4155 This is also one of the larger and principal canals diverting water from the Poudre.

Exhibit Q 8 shows a section of the Poudre Valley Canal with an unrepaired break in the outer bank about three miles below the headgate, looking down the canal. This canal is one of the units of the Greeley-Poudre Irrigation System. The sacks shown in the picture were placed to protect the canal against water overtopping the bank. The ditch carries roughly about 200 second feet. If

more water had been turned down it would have endangered this unfinished break, which apparently occurred in 1913.

Exhibit Q 7 shows a loose rock rip-rap on Fossil Creek Reservoir Dam. The inside slope being very steep, the rip-rap is buckling and slipping in places. This is one of the largest reservoirs in the Poudre Valley. The embankment is in very good condition, but the rip-rap is in very poor condition in places.

4156 Exhibit Q 6 shows concrete facing of Terry Lake Reservoir, another large enterprise. This facing is of the best type and in excellent shape. The Fossil Creek construction would be classed as intermediate and Douglas Lake Reservoir dam would be classed as the lowest type of construction.

Exhibit Q 5 shows a house and barn within the irrigated area under the Larimer County Canal in S. W. ¼ of S. W. ¼ of Sec. 14, Tp. 8, R. 69. The buildings are vacant and dilapidated. I observed other similar buildings and lands adjacent of similar character, some poorer, some better.

Exhibit Q 4 shows seeped waste and alkalied lands in Sec. 33, Tp. 9, R. 69, indicated by the whitish tinge, showing an extreme condition. Some land in the foreground is also seeped and waste

4157 land.

Exhibit Q 3 shows seeped waste and alkalied land in Sec. 28, Tp. 8, R. 69, the light color indicating a portion of the alkalied area. This is one of the heaviest pieces of waste and alkalied land I observed.

Exhibit Q 2 shows similar land in Sec. 19, Tp. 8, R. 68, beyond the second fence in the picture, the foreground being plowed ground.

Exhibit Q 1 shows similar land in Sec. 19, Tp. 8, R. 68 covering also a portion of the lands shown in Exhibit Q 2.

The concrete facing on Lake Hattie Reservoir on the Laramie plains is of the same type as that on the Terry Lake Reservoir and compares very favorably. Examined the first four miles of the Poudre Valley Canal, the main diversion canal of that District. I believe there are also some small feeders from intercepted tributaries of the Poudre or South Platte. This canal is the primary means of carrying water though they can secure water by exchange from reservoirs above or below their canal lines. Water could be exchanged and carried through the extension of the Pierce Lateral and also through the Middle Lateral. The first sixteen miles of the

4159 Poudre Valley canal is practically completed, although in order to carry its intended capacity of about 800 second feet, a section constructed on a steep hillside through shale would have to be lined with concrete to insure safety. There was considerable seepage on the slopes below the canal. It was seeping heavily in Sec. 18, Tp. 8, R. 68 on the hillside, and a strip of land about a mile in width immediately below this canal shows seepage for a distance of about eight miles below the point where it leaves the Poudre cañon. The seepage has been considerable early in the season, when carrying less than one-third of its capacity, and at full capacity, the seepage would be large. Examined the extension of the canal for the Greeley-Poudre District, making examinations of sections from

time to time to a point about eight miles southeast of Wellington.

4160 A short distance west of Wellington there is an uncompleted section where shale is encountered. This is unexcavated and there are stretches beyond Wellington apparently where no right of way has been secured which are unexcavated. Some of these sections are about half a mile in length so that a large amount of construction must still be done before water could be run to the heart of the district through the main canal. In the vicinity of Wellington I would say that the seepage would be near that of existing canals, but farther on into the Greeley Poudre Irrigation District, where the soil is more sandy, the seepage losses would undoubtedly be greater.

4161 The soil in the District lying east of the Union Pacific Railroad branch from Camfield to Purcell is more sandy than the general run under the existing large canals in the Poudre Valley. I observed some lands being dry farmed within the irrigated areas of the district, numerous tracts, some of them large, some appearing recent and some of some years' standing. Considerable dry farming was also being carried on along the foothills and along the interstices of the irrigated areas overlapping into the irrigated portions, especially under the North Poudre Canal. Assume that dry farming is successful because of the large area so farmed.

4162 Cross-examination by Mr. Delph E. Carpenter:

Heard part of Mr. Wortham's testimony relative to improvements and enlargements contemplated on Poudre Valley connection with Greeley-Poudre System. Am not familiar with specifications as to fact that concrete lining is contemplated around the steep hill of which I spoke. If there were a mile of concrete lining it would cut off seepage.

I did not consult with those who have made careful and detailed investigation of seepage of Poudre Valley Canal. Did not know that such losses had been measured for canal. Know that seepage at Shipp's Hill area was large, but did not know 90% of seepage

4163 for entire canal was on Shipp's hill area or that this section is to be lined. Beyond section of which you speak, canal is seeping badly as I have heard. There is nothing surprising in canal constructed newly through region, even in Laramie Plains region, losing water from seepage. We expect some seepage from these canals constructd on side hill, especially in early years. Do not know how many years Poudre Valley has been constructed or operated.

Poudre Valley Canal is above all other irrigation canals in Poudre Valley. Water seeping from it is caught up and used by other canals, with exception of loss by evaporation. On portion extending along canal from one-half to a mile wide there are some ponds, occurring between Poudre Valley Canal and Larimer County Canal, which would intercept some of these seepage waters and they would never be utilized by other canals for irrigation.

Do not know seepage of Larimer County Canal immediately

below this Poudre Valley Canal, 20 years ago, when it was constructed, nor whether it seeped in early years about as bad as the Poudre Valley Canal. Know that canals fill up in measure and seepage decreases after they have been in operation a number of years.

4164 I observe Exhibit Q-16, a photograph of log crib and rock filled diversion dam at headworks of Poudre Valley Canal. Do not know what plans Greeley-Poudre System contemplates for construction of diversion dam at that point. I did not state that structure shown in picture is final structure of that system. I exhibited picture as representing existing conditions. Did not hear Mr. Wortham's testimony to effect that very expensive concrete or reinforced concrete structure was to be put across river at this point.

Did not know that section of canal shown as rock crib in picture where man is standing was supposed to be covered with concrete.

If a large concrete dam is put across river and new diversion gates of most modern pattern and general concrete bank covering and reinforcement where rock cribbing stands, costing upwards of $30,000, is installed, it would somewhat improve present condition.

4165 Did not know that that was part of the plan of the Greeley-Poudre System and do not know their plan of construction of improvements.

Portion of canal in vicinity of Wellington which is incomplete is where work must have stopped.

Believe I heard it alleged that construction of the Greeley-Poudre System was stopped as result of this suit. Have heard it so stated under oath in this case.

My knowledge of reasons for conditions I find on Greeley Poudre System is quite limited. Simply made field examination to find status of canal as it is.

4166 Knew it was intention to ultimately complete Poudre Valley Canal and to enlarge portion from headworks down. Presume when canal is repaired and concrete lining put in, capacity will be increased. This will be necessary if they are going to have ample water supply for area of land contemplated.

Poudre Valley Canal is principal canal of system. I stated capacity about 800 cubic feet per second. I did not consult Mr. Wortham's testimony to find out how large they intend to make this canal and of what carrying capacity. If he stated it was to be 900 cubic feet per second it is probable that he knew whereof he spoke. I am not disputing any statements made by him.

It would be necessary to carry greater portion of water through this canal in order to water Greeley-Poudre District. If canal were allowed to lose water by any means it would not reach district. I really feel that competent engineers in Poudre Valley are able to cope with that situation when they meet it and at the time when the canal system is completed.

4167 Did not follow line of Laramie-Poudre Canal, being extension of Poudre Valley Canal beyond Cobb Lake Region. Did not go beyond county line between Larimer and Weld

Counties. I only intend that portion of my testimony concerning sandy condition of soil to apply to portion of canal east of Nunn and Pierce. Was in vicinity of McGrew Lake. Did not notice character of ground excavated in ditch near that point. Saw some laterals that had been excavated and where furrows had been plowed and noticed sandy condition of soil and where sand had blown and lodged along fences and some other parts of district. Do not know that same condition prevailed on original Larimer and Weld Canal area. Did not know that all of the land under that canal was so light that it blew easily in early days of reclamation. Observed considerable sand up around Camfield and Purcell and east of there. Did not dig down to ascertain how deep it went. Saw two or three laterals where cut was 2 or 3 feet deep.

Did not investigate extension of Union Colony Canal No. 2 where it forms southern border of district near town of Barnesville. Did not know that that canal traverses a mile or two of localized sandy area commonly called sand hills. Did not know that water is conveyed through these sand hills easterly across Crow Creek and down on east side of creek in vicinity of Wadlin Reservoir where it irrigates some 3,000 or 4,000 acres. Am not familiar with conditions there. Am not aware of fact that in third year of use of that canal seepage was not any more in the sandy portions of the canal than it was along whole line.

If any water should escape from upper line of Greeley Poudre Canal, the lands that would be moistened by the water so escaping would be within the Greeley-Poudre District. If it should finally form into seepage or return water streams in the depressions, the lower portion of the Greeley-Poudre District could accumu-
4169 late and re-use the water. The middle or center lateral portion would so use it as would also the March Reservoir and Camfield Reservoir. It would be entirely feasible for the various land owners throughout the region to utilize the seepage water to the same degree and in the same manner as they do elsewhere in the Cache la Poudre Valley.

Observed some use and re-use of water by accumulation in seepage reservoirs and streams throughout Cache la Poudre Valley.

It is not my intention in my testimony to make prophecy of how the Poudre Valley Canal will appear when it is completed as contemplated by the Greeley Poudre Irrigation District.

Do not know what the loss of water is through the 80 to 100 miles of Union Colony Canal No. 2 in the Cache la Poudre Valley, or of the Larimer and Weld Canal. Know generally that it has been stated that losses in Poudre Valley approximate about 30% through canals in transit. Believe that includes both canals and
4170 general distribution works. Nevertheless this water which is lost in Cache la Poudre Valley from canals and reservoirs goes down into earth, reappears again and is put to use, several times over, before it finally returns to principal stream, when water table is built up sufficiently to bring it out upon lower lands.

Peculiar condition is that return and seepage water usually reappears in Poudre Valley.

Do not intend by my testimony to convey impression to court that what they see by photographs Q-16 and Q-8 would indicate appearance of principal canal or any of canals of Greeley-Poudre System. These are merely submitted to show present conditions. They appear as they did at time work was stopped. Referring to Exhibit Q-16, was not advised that portion next to headgate marked by crib fill was originally of different construction which was washed out by flood. This exhibit was submitted to merely show semi-permanent condition of structure.

Cross-examination by Mr. Fred Farrar:

Visited practically all headworks on Poudre River from beginning down to Greeley. Have photographs of other headworks.
4171 Do not recall number. Think there were something like 60 photos taken on trip. Don't know how many diversions there are from river. There are a number of diversions on Poudre River that I do not show in photos. Those shown in exhibits were submitted to show typical structures of the three types discussed.

Made photograph of headworks of Pleasant Valley and Lake Canal. As I remember it has no dam. Taps river at such grade as to be able to draw water at all stages without dam.

Took picture of Jackson Ditch headgate but did not introduce it in evidence. I recall headworks of that ditch. It is a very modern and well constructed piece of work. It could be compared with Larimer County diversion dam or Larimer County No. 2, all three of them being concrete structures. As I recall these were
4172 only three concrete structures I observed on river. I observed diversion works at head of Cache la Poudre No. 2 Reservoir Inlet. Did not visit headworks of North Poudre Canal or make any inspection of that canal at all. Did not visit Halligan Dam. I have heard that headworks of North Poudre Canal and dam at Halligan Reservoir are among most modern known to irrigation construction.

My instructions were not to include North Poudre System. North Poudre System is one of essential factors of irrigation of Poudre Valley. In treating subject of irrigation of Poudre Valley, I could not separate North Poudre from main branch of stream. There was no intention to omit that.

Diversion shown on Exhibit Q-16 is made from Poudre
4173 River. Main body of water shown in Poudre River. It correctly represents flow of river on April 21, 1914. This diversion is above all diversions on Poudre River except North Poudre Canal and municipal supply for City of Port Collins, which diversion is up in cañon of river. The Poudre Valley Canal is carried through lower portion of Poudre Cañon.

Shipp's Hill, which is shown on Exhibit Q-8 and to which Mr. Carpenter has referred, is on edge of natural cut or break through outlying foothills or hog backs of mountains. It is a short distance

above cañon in this range of hills through which river passes. It is within the cañon above Belleview.

The Larimer County Canal of the Water Supply and Storage Company cuts around edge of this hill. That and the Poudre Valley Canal lie parallel to each other. This is true from this point in general way till they enter plains. Poudre Valley canal runs along base of hog back from point shown in picture Q-8 for distance of about 5 miles. It passes through country which would require rock or loose rock work. Majority would be considered rock work. Observed wide 30 foot cut through limestone shale ledge a few miles beyond this point. From this point Larimer County Canal tends more directly east.

On Exhibit Q-19, photograph of dam of Ames Ditch, Poudre River is shown. Dam is located in outskirts above Fort Collins.

Lands formerly irrigated by this canal are northeast of
4175 town, outside of city limits of Fort Collins. I am not able to define corporate limits of that town so as to state whether portion of lands are at present in city limits. At any rate they were immediately adjacent to territory of Fort Collins.

Did not make investigation to learn whether or not this Ames Ditch is now used for irrigation of land. Did not know that water from this ditch had for a long time been transferred through change of point of diversion proceeding to other ditches higher up the river. Had no knowledge of the ditch other than field inspection. Do not know whether or not this is headgate of ditch commonly known as Ames Ditch. Did not trace the canal. I do not know of a Coy Ditch. Do not know whether or not water is now diverted from this headgate by means of this dam. From condition of ditch, I assumed it was diverted.

4176 Mr. Farrar: Would like to state, Mr. Meeker, that think you have made mistake in name of this ditch and that it is what was formerly known as Coy Ditch which formerly did irrigate piece of land which is now within city limits of Fort Collins.

(Witness continuing): That may be true. Dam is there and represents diversion and headgate is in condition to operate and ditch is in fair shape. The Fort Collins Quadrangle of U. S. Geological Survey indicates ditch of approximately 1½ miles in length. Greatest lateral distance from river is about ¼ mile.

Observed no connection between ditches indicated by photographs Q-20 and Q-13 known as Box Elder and Spring Creek Ditches. I observed a similar ditch indicated on map as Box Elder Ditch, was flowing across Spring Creek Ditch. Did not make observation to ascertain whether or not they were consolidated at upper end. It is possible, from conditions, that dam indicated by picture Q-20 as diversion west of Box Elder Ditch has been abandoned for number of years and water has been diverted through ditch called Spring Creek ditch. Upon examination of plat I find no creek called
4177 Spring Creek which rises in foothills to Southwest of Fort Collins and joins Poudre River short distance below Fort Collins. I find canal called Spring Canal coming from intermittant stream.

Mr. Farrar: I would like to advise you that the authority which you have consulted there is in error in this name and that the canal which you have mentioned is really the Spring Creek Ditch.

(Witness continuing): I find Spring Canal southwest of Fort Collins, if that's what you mean by this Spring Creek Canal on map. Did not follow this canal to see where it went or what land it irrigated. Observed it in crossing on road three or four places.

In observing headworks shown by Exhibit Q-13, was impressed with size of headgates and capacity of ditch. It is a large canal. Did not investigate to learn whether or not it was in fact inlet to Fossil Creek Reservoir.

Mr. Farrar: That is a fact, Mr. Meeker, that the ditch you have described here as Spring Creek Ditch is simply a feeder to Fossil Creek Reservoir. Let me call your attention to your exhibits Q-11, Q-12 and Q-14, all of which, according to legend, pertain to the Arthur Ditch. Where is this headgate with respect to the Arthur Ditch?

(Witness continuing:) Headgate of Arthur Ditch is mile and
half northwest of city limits of Fort Collins. Did not observe
4178 relationship of city to this headgate. Do not know whether
or not city extends almost to it. As I recall it was about 2 miles from city. Arthur ditch runs southeasterly to Fort Collins, through western half of city. Did not trace length of ditch. Know that the ditch runs through Collins. Do not hear it called City Ditch. I did not dig up pedigrees of these ditches.

I did not know that this ditch was an old ditch which formerly supplied water for irrigation of city of Fort Collins and which has now been practically abandoned because of more modern methods
adopted in that city. The waste or stop-gates shown on
4179 Exhibit Q-11 were about one quarter of a mile below the head-
gate. I am unable to answer how much land lies under this ditch. I did not know the major portion of the appropriation made by this ditch has been transferred to other ditches, notably the North Poudre.

From my observation I would not say that the small ditches of early appropriations which lie close to Poudre River are absolutely abandoned. I would say some water is being diverted through them at times. They did not have appearance of being kept up and maintained as did the larger ditches. That would not indicate that their use had been abandoned or superseded by upper ditches, without further examination. I did not go into that. I am not able to express any judgment on the matter from knowledge, other than from this condition and the fact that some water is probably diverted through them from time to time.

I would consider these small ditches close to river, such as Arthur and Ames Ditches, which I have shown in my photographs as typical of smaller ditches and of poorer type. I am unable to state whether or not these are older or later appropriations compared
with bigger ditches that head further up stream. I heard
4180 Professor Carpenter testify in this case relative to develop-
ment of irrigation in Poudre Valley. I recall that he testified

that early systems were those smaller ditches close to river, requiring no great cost of construction and that these were gradually superseded by ditches with extended use of water further out.

History of all irrigated areas along rivers is that some of these smaller ditches are abandoned from time to time. Have never made any investigation in Poudre Valley in order to ascertain what percentage of appropriations made by smaller ditches has been transferred to higher ditches and lower ditches practically abandoned.

Exhibit Q-18 shows diversion works of Canon Canal, about one mile down stream from headworks of Poudre Valley Canal. Land irrigated by this canal is within canon as compared with Plains area. This canal is really a small mountain ditch irrigating a small amount of land inside hogbacks. I so observed it. It is
4181 small ditch and could not irrigate very much acreage and that was adjacent to river. The land lies above point shown on my Exhibit Q-8. Did not learn how much land was irrigated or have any idea. I made some inquiries of a ranchman to ascertain whether or not this ditch had been abandoned or transferred and was informed that portion of its water had been transferred and conveyed through Poudre Valley Canal. That was only information I had on that point.

I am not aware of the fact that larger portion of appropriation originally made by this ditch but which has been transferred, has been subject to abandonment suit and which has resulted in adjudication of abandonment. Am not familiar with legal history of Poudre Valley ditches.

Referring again to Ames Ditch, I have no information to effect that abandonment suit is directed toward appropriation given to that ditch at present time.

With relation to Exhibit Q-7, will state that I never saw Fossil Creek Reservoir since its completion, when it was not filled or
4182 partially filled with water. Would say the dam is about 35 feet high. All of the rip-rapping, which I saw was that exposed above water level and shown in photograph. I did not know that this rip-rapping, which appears to be breaking in spots, is one of finest examples of rub-le rip-rapping in irrigation history.

Bulletin 134, Office of Experiment Station, Department of Agriculture, Plate 5, represents rip-rap facing on dam of Fossil Creek Reservoir. From photograph it appears to be continuous slope, but from personal inspection, slope is very steep above water line at time I observed it. From photograph appearing in bulletin, it is apparently continuous, moderately steep slope. Further referring to the same bulletin, I find that, according to the plans, it has a slope of 2 to 1 on both sides. That is a steep slope for recent practice of loose rip-rap. It is steeper than they put it on today. Natural slope of earth is about 1½ to 1.

4183 Did not hear testimony relative to dam of Wheatland Reservoir No. 2. Don't know what slope of that dam is. Upper portion of dam is 2½ to 1 on water side and on outer side slope is considerably steeper. Water slope on Wheatland dam is more than on Fossil Creek Reservoir and on outer slope is less.

Wheatland dam is rip-rapped with loose rock, thrown in promiscuously. Rip-rap is not as good as that on Fossil Creek Reservoir, which is shown in the plate in the bulletin. Do not know
4184 capacity of Fossil Creek Reservoir.

Mr. Farrar: I will state that capacity is approximately 525,000,000 cubic feet or approximately 12,000 acre feet.

(Witness continuing:) That is less than 1/5 of capacity of Wheatland Reservoir and about 1/5 capacity of Lake Hattie Reservoir. If capacity of Wheatland Reservoir were 126,000 acre feet, then Fossil Creek would be about 1/10 the capacity, but I know it to be fact that Wheatland Reservoir active capacity is about 100,000 acre feet. However that may be, there is absolutely no comparison in size. The Fossil Creek is very small as compared with the other.

Fossil Creek Reservoir is one of largest reservoirs in Poudre Valley. Am not familiar with capacity of all those reservoirs. Am not aware of fact that additional storage capacity is maintained in Fossil Creek in addition to that originally contemplated by earth dam at spill way.

Land shown in Exhibit Q-5 is irrigable. It is under Laramie County Canal and as I recall, is immediately to right of little
4185 orchard land cultivation. This land was a knoll and was too high. Observed a reservoir lying a little to the north of it but did not know its name. Observed a limestone-shale formation extending north and south through that immediate area. Think land shown on Exhibit Q-5 was agricultural land. Do not have any idea for reason of its abandonment. Saw number of buildings abandoned throughout area. All of them, while they might be under ditch, were without irrigation. Some were under irrigation.

I do not know F. C. Grable. Have heard of him. He was one of promoters of Lake Hattie enterprise; also promoted one of irrigation enterprise in Poudre Valley. I did not know that this place which I saw was part of Mr. Grable's promotion. Did not investigate to find out. I do not know what became of a number of places exploited and endeavored to sell to so-called dry farmers.

4186 Land shown on Exhibit Q-3 is about 2½ miles below mouth of Poudre in an easterly direction and on north side of stream. Hills in immediate background are hogbacks, an anticline formation. This wet land shown in picture is about ½ to 1 mile from hogbacks. Land at point from which picture is taken and lying to eastward of wet place is higher land. There is general depression through where water is collected. Object looking like tower in immediate background toward left end of picture is a derrick where they were attempting to drill for oil. I did not go to the well.

4187 Did not observe a flow of water coming from that well. Did not know that the well, instead of discharging oil is discharging water. Land to left of picture showing water might be affected by this well, but land to right could not be.

Lands shown on Exhibit Q-4 are a little northwest of Fort Collins and on Exhibits Q-1 and Q-2 a little to northeast of Fort Collins.

Q-4 is taken short distance below Poudre Valley Canal and above Larimer County Canal. Q-1 and Q-2 are taken below Larimer

County Canal. All of these seeped lands are in lower ground. I know where Box Elder Creek is. These lands are west of Box Elder Creek. Q-4 lies to west of Dry Creek. Q-4 lies within 2 miles of foothills. Other two lie 5 miles from foothills. Country in districts
4188 where these pictures are taken is of broken topography. It is not the smooth plains country that prevails a little further from mountains.

Embankment appearing in immediate foreground of picture Q-4 is Poudre Valley Ditch. Did not recall any other embankment there. Could not tell whether or not land was under cultivation or ever had been. Do not know location of proposed reservoir No. 14 of North Poudre Irrigation System.

Seepage water from the areas which I have shown in pictures is undoubtedly picked up by canals at points below. I observed a drain
4189 ditch and tile drainage being installed in Section 28-69. Do not know the name. Did not hear of the Fitzpatrick drain ditch or of the Earle Drain Ditch or the three Douglas seepage ditches. My investigation did not include drainage ditches. Am not able to give you any information at all on that subject.

I assume that water from these seeped areas is picked up and utilized for purpose of irrigation. It would be picked up automatically by some of those canals. I observed one specific instance where ditches are being constructed for that purpose.

By dry farming I mean cropping and cultivation of land without application of water from canals or ditches. Application of water builds up water table in soil. I would not consider as dry farming conditions of soil where water appears from building up of underground water play. I would call that seepage irrigation.

I spent four days in Poudre Valley.
4190 I do not mean to be understood as saying that irrigation is unnecessary in Poudre Valley.

Exhibit Q-17 photograph of diversion dam Greeley Municipal water supply. A conduit taps river directly for that. On further side of river there is settling basin. Some sort of dam is necessary to get water from river but just as to where the point of diversion would begin and end I am unable to state. Point shown on Exhibit Q-17 is about 37 miles from Greeley.

Did not produce a picture of diversion works of Fort Collins water system.

Heretofore during testimony I believe some land has been referred to that was irrigated from seepage, and I wish to make distinction, that seeped waste land is land that is not used for any agricultural purpose. My idea is that land might be termed seeped land and might be made available for some use and not entirely wasted. Under existing conditions some land in Laramie Plains is irrigated by seepage that produces pasturage or meadow, purely by seepage. In some instances the irrigation is augmented by application of water from laterals.

ANDREW POPP.

Direct examination by Mr. N. E. Corthell:

4192 I have been living on the high plateau between the Pioneer and the Big Laramie, Sec. 12-14-76, seventeen years, engaged in farming and raising cattle. I raised oats, wheat, barley and a kind of grain they call Polish wheat with a kernel about three times as long as rye, and a heavy long ear. Also alfalfa, native hay and potatoes. I have raised potatoes every year, exceptionally
4193 good crops. About fifteen years ago a patch of eight acres produced sixty tons. I had a letter from the Department of Agriculture at Washington, inquiring about potatoes. They would not believe my statement and wrote me again. Some years are better and some poorer. We have had 4½ tons and 3 tons to the acre and some poorer years, especially when the water supply was poor. The frost did not injure the crop much, though it will often happen in a good farming country. The potatoes that don't get covered over good with earth get touched a little, but I never lost a whole crop. Alfalfa, if we get it irrigated in time, we figure two or three tons to the acre. Have had good crops and some poor ones too, especially when the water supply got cut off, which was
4194 done twice in three years. Three years ago the Water Commissioner put a notice on the headgate that it was closed under order of the Water Commissioner. We got out of water and did not raise any alfalfa at all. The next year we got water and raised some alfalfa. Last year they shut off the water on the first of July. I had between 40 and 45 acres that cut four or five tons of hay. Some of it died out altogether. M. N. Grant's son was the Water Commissioner who shut off the water. I went into see him but he said he could not do anything about it. Have had fair crops of oats, from 28 to 75 bushels per acre. Raised oats every year
4195 except last year, and this year I did not put in any because I was afraid of the water. When I have water I don't need anybody to help me take care of the oats. When I have water they mature. Have had good success with barley, raising as high as forty-five bushels to the acre; also with wheat, as high as forty bushels to the acre, and had some of it left from cutting too late. We raise fine grain. My ground is full of gravel but if you get around in time with the water it is all right. If I have my water that is appropriated, I do not want any help from anybody. I do not believe that they raise any better crops in other parts of the
4196 country than I do. We have our own ditch, the Last Chance Ditch, built in 1882, 1886 and 1888, taken out of the Big Laramie River.

4196 Cross-examination by Mr. Fred Farrar:

I sell my barley to brewery in Laramie. Brewery is not running. There is nobody at the brewery now. Denver fellows ship all beer they want here. Do not know why they closed brewery. I believe on account of some fellows having more capital interested. Man

who conducted business had only small capital and he had
4197 to give up. I could not say whether they got all the barley they needed here. Do not know whether or not they shipped in barley. I sold all my barley there and he said he was well satisfied with it. Next year he gave me some seed, this Mr. Helbig, he gave me 4 or 5 sacks of seed and asked me to try them and he was going to take all barley I raised from that seed. He gave me seed free of charge next year. He was endeavoring to encourage me in raising barley. He encouraged me for his gain.

I believe I brought in a carload of wheat once.

There was mill here but it didn't work. Could not tell you why. I do not raise any wheat now. I raised some three years ago and got burned out and I raised a little two years ago. I didn't have much in I know because I put in most of alfalfa and last year I didn't put in any wheat. I had barley and oats.
4198 I only raised alfalfa and potatoes this year. I had in 4 acres of potatoes last year. If I had had water would have obtained about 400 sacks of potatoes. I had one ton off of four acres, small potatoes, because I wanted to irrigate potatoes when the water was shut off. My potato vines were not killed by frost last summer. I am 18 miles from Laramie River, between Pioneer Ditch and river. I am 6 or 7 miles from Woods Landing. Potatoes I raised last summer are about as big as end of my thumb

I had four or five tons of alfalfa last year, just enough to feed spring calves. I had to buy hay last year to feed my cattle through. I had about 33 head in all. This was horses and cattle. Fed
4199 them through winter on hay I purchased. Bought 8 tons from outfit of Laughlin and Dinman and bought about 14 tons from Benson on Big Laramie. It was native hay. I bought it in stack. With one outfit had to make 3 mile trip and with the other 6 mile trip. Paid $6.50 for 8 ton lot and $6.00 per ton for 14 ton lot.

Cross-examination by Mr. Delph E. Carpenter:

Last Chance Ditch irrigates about 1200 acres. The Lake Hattie Outfit were still running water after my ditch was shut down last year, they ran their ditch all right.

I don't believe we were short of water until after the Lake Hattie scheme was constructed.

We raised Beauty of Hebron and Early Ohio potatoes. The Beauty of Hebron is not any earlier than the Early Ohio but not quite such deep eyes. The Beauty of Hebron is a more salable potato. It is about as early as the Early Ohio. We generally dig potatoes the last week in September.

ANDREW POPP.

Redirect examination by Mr. N. E. Corthell:

4200 I don't raise more grain of late years because I am afraid they will cut off the water. What good is it to put in the

seed and burn the crop out. If they are going to take the water from us, they can take the land too. Running the water in the Lake Hattie Canal did not do us any harm, because the Pioneer Ditch had been running before that and we had all the water we needed. The Water Commissioner shut off three ditches, the Last Chance, the Parker, and Fischer ditches. I did not see water running in the Lake Hattie Ditch, but some of my partners told me it was
4201 running.

Z. E. SEVISON.

Direct examination by Mr. N. E. Corthell:

4202 Have lived in Laramie about six years. Recently made an examination of the irrigation ditches and works and some of the irrigated lands in the Poudre Valley, April 20, 21, 22 and 23, 1914, in company with R. I. Meeker. I was with him the entire trip, present when all of the photographs (Q1 to Q20) were taken. They are fair representations of the subjects, and
4203 the irrigation works shown are fairly typical of the different varieties of structures in the Poudre Valley. Examined all the dams and headgates and portions of all the canals from the Poudre Valley Canal down to the mouth of the river. I noted particularly the alkalied or seeped areas. Out of about 64,000 acres closely examined, we found 933 acres alkalied and worthless, caused by excessive application of water or standing water on land which could not be easily drained. On 35,000 acres not so closely
4204 examined, we found about 450 acres additional—all in the irrigated district in the Poudre Valley and under canals. We examined particularly the Poudre Valley Canal and the extension into the Greeley-Poudre Irrigation District as far as Wellington and various points below Wellington along the extension. The canal was finished from the headgate to a point about one mile east of Douglas Reservoir beyond which the excavation is completed, except where places for structures are still to be installed, as far as Wellington. Below Wellington it was completed in sections, and there were gaps of a few hundred feet to a half mile where no work had been done. It is not in a condition to carry water beyond Douglas Lake. No construction work is going on nor was there any evidence of recent work. On a section of the canal about
4205 three miles in length from a point about one mile West of the range line, between ranges 69 and 70, the seepage is very extensive. Below this section the seepage is about the average for a canal of that size. It was carrying about 200 second feet of water; not nearly its supposed capacity, but all it would carry without additional work, owing to low places in the bank caused by breaks. From a point about six miles below Wellington, the
4206 soil is porous and sandy. I would expect a very high seepage, much more than usual. The efficiency would be low compared with other canals in the same district. Running the canal full would increase the seepage. I recently examined the lands along the Pioneer Canal from Lake Hattie to the Fraser Ranch

and in the neighborhood of the Soda Lakes and between the Pioneer and North Canals to determine the extent of waste or seepage land. I found 325 acres in all the land between the Pioneer Canal and Big Laramie River east of the range line between ranges 75 and 76, and extending to the end of the Pioneer Canal; also in the territory between the North and Pioneer Canals. This acreage is from
4207 actual survey shown by a map prepared by me (Plaintiffs' Exhibit R), indicating the waste or seepage areas by shaded portions. Other areas outlined are small lakes and ponds. I applied the same standard in obtaining this area as in examining the lands in the Poudre Valley and the waste lands are of the same kind. Have also made a survey of the lands in the vicinity of the Bath and Alsop Lakes in the Little Laramie Valley May 18, 1914, finding not to exceed 80 acres of seepage or waste land, exclusive
4208 of the Big Basin.

4208 Cross-examination by Mr. Delph E. Carpenter:

I made one examination of seepage from ditches in Cache la Poudre River. This examination extended over a period of four days. In other words I acquired this knowledge of possible seeping of Greeley-Poudre System through some observation made of that canal during four days of time that I spent in Cache la Poudre Valley. I never had any previous experience with seepage of water from canals in Cache la Poudre Valley.

There are portions of inlet canal into Lake Hattie Reservoir that will seep as much as portions of Poudre Valley Canal. It is hard to make comparison between the inlet to Lake Hattie Canal and the extension of the Poudre Valley Canal commonly known as the Larimer-Poudre Canal. The country is considerably dif-
4209 ferent in each case. There — very different conditions in every way.

We did not follow all along the Larimer-Poudre Canal in order to give this opinion, we just observed it in places. We followed Poudre Valley Canal easterly about 20 miles. Did not follow along the course of it, just crossed back and forth. I followed for same distance Mr. Meeker did. We stopped at point about 2 miles east of range line between ranges 67 and 68. That is as far as we followed canal itself. That is about west line of Greeley-Poudre Irrigation District lands. We made trip through district itself and over north boundary where canal would probably be constructed.

We simply followed canal down a little south to east of Cobb lake.

We didn't pay any particular attention to Larimer County Canal except at places where we crossed it. We didn't follow it any way.

Made careful study of amount of seepage from Larimer
4210 County Canal from river to Cobb Lake. There is less seepage from Larimer County Canal between these two places than from Poudre Valley Canal. Don't know how much. Don't know how Larimer County Canal looked when first constructed. Do not know how that country appeared when canal was first constructed. Do not know how much that canal seeped after its construction.

Do not know how much Larimer and Weld Canal seeped after its construction. Only comparison I can make is at present time.

Don't think that I take these canals as comparison after they have been operating 25 to 35 years, when comparing with new canal. Poudre Valley Canal undoubtedly seeps as much now when it is old as the other canals. I think it is a safe statement to make.

Have been making a study of seepage of canals as an engineer
. since June. Have been engaged in that work in Wyoming,
4211 Colorado and Montana. In district between Denver and Greeley in Colorado. Engaged in that work about one year there on Community Canals and Canals of Farmers Canal and Reservoir Company. Community Canal is not a new canal but there are older canals along South Platte River. My duties were that of construction engineer and seepage was not my specialty. I was construction engineer for the Arnold people. Part of my duties were to see to excavation of dirt and to give estimates to contractors.

Principal spot where Poudre Valley Canal seeps is where it goes around sharp mountain or hogback Do not know name of hill. It is place where canal turns sharply around mountain. I hardly
think that this canal is in condition it will be when district
4212 starts to use it. If that ditch when completed were lined with concrete it would make considerable difference.

Made no measurements of canal to ascertain actual loss by seepage between head of canal and Douglas reservoir. A large percentage of the loss in that canal occurs at Shipp's Hill.

Did not investigate seepage or loss of water from Larimer and Weld Canal east of county line between Weld and Larimer Counties. That canal penetrates the section of country very similar to that irrigated and which will be irrigated by Greeley-Poudre System. Do not know loss of water in that canal between head and lower end. Do not know loss of water in Larimer County Ditch which crosses railroad track immediately south of Pierce and penetrates a similar area. Do not know loss of water in Pierce lateral which crosses railroad track immediately above Pierce.

What little I know about loss of water by seepage in ditches
4213 of Poudre Valley simply by comparing ditches.

And that comparison was one of the things we did in the hasty four day trip that we made during which we took pictures of all of the headgates on the Poudre River, among other things. I grant that the engineers who laid out the Greeley-Poudre System had reasonable degree of information on their subject. It would be reasonable to presume that engineers who have spent years in the Poudre Valley in close contact with ditches of the valley would probably know a little more about loss from seepage from canals than one who ran hastily over it in four days. That would not necessarily affect way in which they laid out their canals or planned system. The first 16 miles of the Poudre Valley Canal from Douglas Reservoir to the river is completed so as to carry about 200 cubic feet of water per second of time and is now carrying water and apparently has been for several years. Do not know how much money

has been spent on that canal. It was some of it very difficult construction.

4214 Do not know plans of Greeley-Poudre Irrigation District with relation to betterments on Poudre Valley Canal, except from hearsay. Did not hear Engineer Wortham's testimony. Did not hear or read Mr. Hedke's testimony. Do not know grade of canal. The areas of seeped land which we found in Poudre Valley cover territory seven miles wide and extending ten miles due north of Fort Collins and a territory five by six miles southeast of Fort Collins. Latter territory is on south side of the river. North boundary of this territory is about 2 miles north of township line between Townships 8 and 9 and south mile is 2 miles north of township line between Townships 6 and 7.

Territory north of Fort Collins is marked by large numbers of reservoirs, both large and small, which occupy this territory. It is very rolling. Southeast of Fort Collins the territory which is seeped is along some draws and creeks and other areas close to river. They are four miles east of Warren Lake. Am not aware of fact

4215 that tile drains have been laid through most of territory east of Warren Lake and pear Poudre River during past five or six years. There are places where tile has been laid and tile on the north side of the river also. Some sections that are drained right considerable north of alkalied land south of river. Area east of Warren Lake south of Poudre is about 140 acres. There is one bunch of 80 acres altogether and the other is a narrow strip extending northwesterly. That is where return from table lands above outcrops on side hill. Area is bottom river land. All of this land mentioned is in Larimer County.

In Weld County we found 450 acres of seeped land. That was in a territory northeast of Greeley principally. It occurred in

4216 small spots only.

We found numerous seepage ditches carrying return waters. It is a fact that in a great many places in the depressions through the country within the Poudre area seepage ditches occur in the depressions and a great many of depressions are drained.

Their waters are used for irrigation in the valley. If any additional seepage water were added to the seepage water already appearing, it would simply mean additional water for irrigation in the valley. Not all of seepage water is available for irrigation. Believe about fifty per cent is not. I refer to losses principally by evaporation. I mean that about fifty per cent of the water which is originally conserved is lost by evaporation and there is some seepage you cannot make use of.

If any accidental seepage appears from carrying water

4217 through Poudre Valley Canal it would simply add to that already existing below canal.

After Poudre Valley Canal reaches the northerly boundary of the Greeley Poudre District, water which happened to escape by seepage would not all of it moisten lands in district. Probably fifty percent of it would. The other would be entirely lost and you would get no benefit from it what ever. It would go into seepage and evaporation which would not be available.

We saw quite a number of irrigation pumps in readiness to use water from seeped areas and lakes formed by seepage. Irrigation of lands was not in full progress at time we were in valley.

Out of 35,000 acres of land in Weld County, we found only 450 acres seeped. We found only about 1½% of lands we examined were in that condition. At least that is what I examined. Do not have any information relative to accumulation of water in the Larimer Poudre Canal constructed and lying northeasterly of land in the district. Did not know that land will stand in that ditch for days without seeping away. Do not know comparative grades upon
4218 which various canals of Poudre Valley are constructed. Did not investigate more than 3 or 4 places along the Larimer Poudre Canal below Cobb Lake. We looked at the canal 3 or 4 places in about 50 miles of its course. We ran onto so many places not constructed or completed and ceased trying to follow canal. There were stretches where canal was not constructed at all for half a mile or so. Could easily see beyond that and could follow canal. Did not have time to travel last 50 miles of canal. Took trip over district to north boundary where canal runs. There were indications of considerable gravel on Lone Tree Flat and right near Nunn and also on Wildhorse Creek a tributary of Coal Creek. Found
4219 little gravel on ridges. Struck the canal in three or four places. Am testifying not so much from examination of canal as from examination of land straight through district. Don't think there is great variation in soil at places I examined. I did not dig myself. Made purely superficial examination.

Larimer and Weld Canal and Larimer County Canal must have crossed same gravelly area on the Lone Tree and Owl Creek drainage and along Coal Bank Draw throughout their courses. They deliver water clear to Crow Creek. And if one ditch is run on more of a grade to a mile than another the first has less chance of silting up than the latter. Now if these older ditches were run on grade 2½ feet per mile and new ditch on little over 1 foot per mile whether or not the latter would silt better than old ones would depend on what velocity two ditches were designed for, which depends of
4220 course also on comparative sizes. Assuming two ditches were practically same size and velocity it would mean that one having greater grade would have greater velocity. One having greater grade and correspondingly greater velocity would not silt as well as one having lesser grade and slower velocity.

If Cache la Poudre Canal, or Larimer and Weld Canal, for example, happened to have grade of about 2½ feet to mile they would not silt as well as Larimer-Poudre Canal would if it only had a grade of 1 foot per mile.

Cross-examination by Mr. Fred Farrar:

We spent three and one-half days in whole Poudre Valley. We started from Laramie at noon and reached Fort Collins in afternoon. Actual time in valley itself was probably 3¼ days.

4221 In examining works from Poudre River south from upper portion downward. Visited 14 diversions in that distance.

We saw 14 principal diversions. Took us three days to go along river. Were not along river all the time. Did not pass directly up and down river. Don't think there were a good many diversions we did not see. Every time we crossed ditch we followed it to its head if we had not already found diversion, that is below head of Poudre Valley Canal.

In this time we examined 64,000 acres land closely for seepage. We found 933 acres of alkalied land which was worthless. We estimated acreage.

During time we were examining these 64,000 acres of land we were also making examination of headgates. 64,000 acres of land is exactly 100 square miles. We also examined approximately 35,000 acres more or less casually upon which we found 450 acres seeped land. That would be approximately 50 square miles territory.

On this 64,000 acres of land we passed along at least two sides of every section. Some cases went into section. During this 3½ days we traveled 360 miles in Poudre Valley alone.

This is the extent of my knowledge of valley.

There are 24,000 acres included in plat Exhibit R which I filed here tonight. It took 5½ days to make examination or survey. Surveys were made with transit and stadium. I actually made survey of superficial areas of all lake surfaces in 5½ days. Had
4223 three men besides myself.

Had transit in Poudre Valley but did not use it.

Year 1913 was rather below normal in amount of precipitation. Seepage should be less. Effect on waste land would be very small I think. Do not think there would have been much difference had I made these surveys of seeped lands in Laramie Plains at end of summer rather than at end of winter. Application of water for irrigation during summer would not increase size of class of lands I have in mind. There would be no material change. That is class shown on Plat Exhibit R. Effect of greater precipitation would be to make more ponds but I do not think area of waste land would change.

Cross-examination by Mr. Delph E. Carpenter:

On James Lake outlet on Laramie Plains and ditches did not do any concreting to prevent seepage. We expect certain amount
4224 of natural and incidental seepage in every ditch system.

Z. E. SEVISON.

Redirect examination by Mr. N. E. Corthell:

4224 The 1914 precipitation in the Laramie Plains region was very much greater than in 1913. There was a most unusual snowfall early in the winter, saturating the ground to a greater extent than usual and there were more ponds and lakes than usual this spring.

J. A. ELLIOTT.

Direct examination by Mr. John D. Clark:

4225 I am the present superintendent of the system of the Wyoming Development Company near Wheatland. We have never experienced a great deal of seepage from the laterals. What we have had practically all comes from No. 1 Canal No. 1 Lateral, our largest lateral which has the heaviest grade on the system, fills up very little except in a very few places. It keeps scoured. All the smaller laterals fill up and require cleaning each year. We gauge No. 1 Lateral from time to time and while it is on a ridge, we have not experienced a great deal of seepage because the bottom is not through the subsoil which is of clay. It has the same effect in preventing seepage as silt in the canal would have. Two
4226 years ago, by shutting the gates and measuring the water at our large distributing laterals on No. 1 we found about 18% loss in 30 miles. Similar gaugings on No. 2 Canal showed about 6%. The diversion dam at the head of No. 1 Canal is built on piling with sluice boards to throw the water into the canal when running, and at other times the sluice boards are taken out to allow the water to go down the stream. At the head of No. 2 Canal, we have a concrete overflow dam, an effective modern dam capable of diverting all the water in the stream at that point. In run-
4227 ning water in Canal No. 1 we at all times have to allow a certain amount to go down to Canal No. 2. If it leaks through No. 1 dam, we don't consider the water lost because it is picked up again at No. 2. This is why we have never attempted to prevent loss at that point, the final distribution being from No. 2 Canal, where the dam is effective and kept in repair. Water will leak through at various points, but not to any great extent, the leaks being repaired as often as they occur. The dam at the head of No. 3 Canal is similar to that of No. 1, only it is on mud sills instead of piling, an effective dam used to divert water into No. 1 Reservoir whenever the ditches are not filled with snow and ice between irrigating seasons. This dam is sufficient to divert all water
4228 available in the stream during that period up to the capacity of the ditch. It is located on Sybille Creek between No. 1 and No. 2.

4228 Cross-examination by Mr. Delph E. Carpenter:

Modern structure was put in at head of No. 2 Canal 2 or 3 years ago I have forgotten which. Prior to that time I don't really remember much about No. 1 Dam or No. 2, but I think all gates were in working order. At any rate it was replaced by modern structure during last two or three years. I have forgotten whether it was 1910 or 1911.

JAMES M. HOGE, a witness in behalf of the Complainant.

Direct examination by Mr. N. E. Corthell:

4229 Have lived near Platteville, Weld County, Colorado, for five years, engaged in farming. Lived in Wyoming for eighteen or nineteen years prior to that time, engaged in ranching and a little farming on Sand Creek southwest of Laramie, and also on the west side of the river. Was farming in Sections 20 and 19, Township 14, Range 74; also in Section 35, Tp. 15, R. 75. The first place lies in the Sand Creek valley and the second north and
4230 west of the river under the Pioneer Canal. On the south side I got water from Sand Creek through an individual ditch. Raised wheat, oats, potatoes and alfalfa for ten or twelve years under irrigation. Had good results, raised fine potatoes and alfalfa, and I never raised better oats and wheat than up there. The crops fully matured. After hauling three loads out of eight, I threshed 109 bushels of wheat off 3 1/3 acres out of the
4231 five loads left. Had good yields of oats, threshing about 668 bushels of wheat and oats. I had ten or twelve acres. Had the best potatoes one year I ever raised. The yields were pretty generally good in quantity and quality. Had very good alfalfa for a few years, but only had 6 or 8 acres. The yields in quantity and quality of these crops in Wyoming compare very favorably
4232 with the yields in Colorado and the net results on the hardier grains and vegetables were about the same in Wyoming as at Platteville, the markets being a little better than in Colorado, so that the net financial results were better. In Colorado I have been raising wheat, oats, sugar beets and alfalfa, a few potatoes and some cabbage. My farm is situated about twenty miles from Greeley on the South Platte River valley west of Platteville. Lived
4233 thirty-five years in southwestern Pennsylvania before coming to Wyoming. Crops raised and results obtained from farming in Wyoming were just as good as in Pennsylvania, except they raised winter wheat in the latter state. I raised spring wheat here. Don't know what winter wheat might do.

4233 Cross-examination by Mr. Fred Farrar:

Have not had occasion to observe farming conditions in Pennsylvania since leaving there. My comparison is based on conditions as they existed 25 years ago.

We feel that we are in one of best farming sections of Weld County. As matter of fact, we have not shown development in that section of country that they have in others. They are more backward than around Greeley. I have water in Lupton Bottom Meadow Island No. 1 and Meadow Island No. 2 Ditches. Am one mile from Platteville. One place is immediately on Platte River bottom. There is one place just half mile back from first. Immediately west of me there is high mesa. Some of the land southwest of me is under ditch from Platte River. On west side the water is from the St. Vrain, and Boulder Creek. It is only one mile from edge of bluffs

from our place. Bluffs come in almost immediately to river at Platteville. Irrigated area is confined almost entirely to intermediate country between these bluffs. Think Stanley Lake system brings whole country in. That is not yet developed. That is project which contemplates storage of water up toward Denver. This
4235 storage is outside of valley of Platte and really in valley of Box Elder. As matter of fact, highest ditch irrigating in my section is on east side of river and is what is known as English Ditch and passes along bluff about half mile from town of Platteville.

Have been familiar with Platteville five years. Did not know it before that. Passed through it. Know that town is of rather early settlement. Town is no larger today than it was 30 years ago. Eight miles below Platteville there is new town called Gilcrest. Town of probably 250 people. It has grown up in last 8 years.
4236 Six miles below there is town of La Salle which has been town only within last 10 years and previous to that was railway station. It has quite good growth. Nine miles south of us is town of Lupton, which has grown to be quite a town within last 15 years.

Platteville has not been able to show any such development. Would not say that it is due to fact that there is practically no body of irrigated land in that vicinity. Think it is because the town has always been a cow town, until sugar beets came up. That was real industry until last few years. It has always been handled as cattle country up to that time. Wintered their cattle on Platte and grazed them out on country east and southwest until beet industry began to be interesting.

Sugar beet industry commenced when Greeley factory started. Did not know that first factory in Colorado was at Loveland and constructed in 1901. Am not familiar with history of sugar
4237 beet development. Ditches I am under have no reservoir water. They depend entirely upon direct flow of stream. At that point in summer water in river is very low. I am not short of water. Some of people in vicinity are short of water.

Redirect examination by Mr. N. E. Corthell:

Think we got better than average acreage of sugar beets last fall. Better yield per acre. It is pretty good from year to year.

Recross-examination by Mr. Fred Farrar:

Could not say that my crops of wheat raised on my Sand Creek Ranch in Wyoming were uniform from year to year. The yields I have given were based on my experience for a few years. Have some pretty good crops of oats. Other yields which I have given in Wyoming were based upon extraordinary experiences rather
4238 than upon the general experience.

Z. E. SEVISON.

Direct examination by Mr. John D. Clark:

4239 From April 26th to May 18th I made surveys of sections on the Laramie Plains, and prepared maps marked Plaintiff's Exhibits S-1, S-2, S-3 and S-4. These blue prints show correctly certain specified features in each section but not all
4240 the physical or cultural features. The Murphy Ditch shown in map S-1, with headgate on the north bank of the Laramie River in the S. E. ¼ of the S. W. ¼ of Sec. 36, paralleling the Sodergreen High Line Ditch and running below it for about half or three-quarters of a mile is an entirely separate and distinct ditch from the Sodergreen Ditch. Both are in actual operation. I found alfalfa on Sec. 36 in the S. ½ of the N. E. ¼ between the Murphy Ditch, and the Pioneer Canal and two laterals of the Murphy Ditch, all irrigated from the Murphy Ditch, approximately eighteen acres. This field is perfectly plain and the alfalfa is in good condi-
4241 tion. A plane table survey is usually considered the most accurate way of making a survey of this kind, and if properly done, should show all features of this nature.

From the same map, the dotted lines in Sec. 36 indicate the road leading from the Pioneer headgate in a westerly direction from the county road, known as the Woods Landing road across the Murphy Ditch and lateral and the Sodergreen High Line Ditch, all in the S. W. ¼ of the N. E. ¼, Sec. 36; then runs about 400 feet northwesterly; then turns and runs southwesterly across Sec. 36; thence due West to the county road. I am acquainted with the area shown on Sheet No. 1 of Defendants' Exhibit 114, purporting to be a plane table survey map of the same section, designated as "meadow." A portion of this is alfalfa, about eighteen acres in the S ½ of the N. E. ¼. The rest is meadow and the plane table map is in-
4242 correct in this particular. The road shown on this map running from the headgate of the Pioneer Canal, marked "Laramie Canal" in a northwesterly direction is incorrect above the Sodergreen High Line Canal. Beyond that point it runs as shown in the blue print, S-1.

Map S-2 shows Sec. 16, Tp. 15, R. 74 with an oats field as indicated, 43.6 acres in area, determined from accurate survey. The acreage (53.3) shown on Sheep 14 of Defendant's Exhibit 114 is the same field but is incorrect as to acreage. The oats field
4243 does not extend to the east line of the section. The nearest point is about 400 feet.

Map S-3 shows Sec. 22, Tp. 14, R. 76 with the Parker Ditch and the Popp and Pahlow Ditch correctly located. Under the Parker ditch there is irrigated pasture and meadow land watered from the Bloom lateral of the Pioneer Canal. If a plane table survey were made of this section, I don't think it would be possible to overlook the Bloom lateral or the irrigation from it. About 16.3
4244 acres in the S. E. ¼ of the N. E. ¼ is irrigated from the Popp and Pahlow Ditch. The total area of irrigated land in this section is divided as follows:

An oats field	32.7	acres
Alfalfa	10.4	"
Meadow	69.9	"
Irrigated pasture	45.3	"
Total	158.3	"

Sheet 2 of Defendants' Exhibit 114 is incorrect as to the shape and area of the meadow; also in omitting the alfalfa field of 10.4 acres east of the Parker Ditch, but not irrigated from it.
4245 It is also incorrect in showing no irrigated land above the Parker Ditch, where 66.1 acres are irrigated. The Popp and Pahlow Ditch is incorrectly shown, in fact, it re-enters Section 22 and irrigates lands there. The Parker Ditch is incorrectly shown. If a plane table survey were made of that section with any degree of care, it would not be possible to overlook the existence of the Bloom lateral and irrigation for a considerable tract from it on the alfalfa field below the Parker Ditch.

Exhibit S-4 shows Section 14, Tp. 15, R. 74, containing 379.6 acres of irrigated land, divided as follows:

4246

Alfalfa	73.2	acres
Old plowed ground	36.2	"
Meadow	207.2	"
Irrigated pasture	63.	"

Sheet 20 of Defendant's Exhibit 114, showing this section, is incorrect in showing an alfalfa field of 16.8 acres instead of 61.2 acres, and also in showing two separate fields of alfalfa in
4247 different locations. There is no such fence as that shown running east and west on the center line of Sec. 14 in the Defendants' survey. The fence at the southern boundary of the pasture is about 1000 feet further south than shown. The northern alfalfa field shown to extend to the north line of the section does not extend within 600 feet of it, and is bounded by a fence. A waste ditch from the Pioneer Canal comes into this section in the northwest corner for a short distance and enters the section again in the N. W. ¼ of the S. W. ¼ and runs in an easterly direction to a point where it crosses the old Wolcott Ditch, which is on the north and south center line of the section, and about 1400 feet from the southern line of the section, where it empties on to the low land and the water spreads over the land between the Wolcott Ditch and the river, where it is ordinarily used for meadow land. The
4248 defendants' map of this section is incorrect in that it fails to show an area of 14.6 acres of plowed ground in the N. E. ¼, plowed in 1913 or previously. All the features discussed existed in 1913, the alfalfa fields having been in existence for one year or longer. The errors shown in the plane table survey are not permissible and it should not omit the features I have shown. The lake and county road as shown on plane table survey are approxi-

mately correct. The section corners were all found by me
4249 except the southeast corner, so that there would be no difficulty in ascertaining the boundary of the section. There is a waste ditch at the lower end of the Pioneer Canal, which has been in existence, to my knowledge, for six years, and is easily found. The notation: "Total area of all lake surfaces 743 acres; total area of all seeped waste land 325 acres" on Exhibit R, indicates that this is all of the areas of that kind that lie within the area shown on this map.

42449 Cross-examination by Mr. Fred Farrar:

Referring to my Exhibit S-3 which shows Section 22, Tp. 14, N., R. 76 W., discrepancies which I found between my survey and plane table survey are in lands north of county road. Parker Ditch is inaccurately shown on plane table sheet south of county road. Also Popp and Pahlow Ditch. Parker Ditch is very much out of alignment on plane table sheet. Plane table sheet shows this
4250 ditch running about three quarters of a mile outside of section south of county road. In other words, if I am correct, route of ditch is to east of point where they found it. There is no loop in ditch like is shown on plane table sheet.

I used transit in making my survey. I ran lines of ditch with transit. Had two men assisting me in survey.

When I mentioned finding laterals I referred to Bloom Lateral which is northern lateral. It is ditch practically as large as Parker Ditch. I did not know that the surveyors in making the plane table survey did not attempt to show laterals. Do not think in this case there would be less ground to criticise than if they had attempted to show lateral ditches. If they don't show them
4251 on plane table sheet it gives wrong impression of conditions in that section.

Waste ditch at lower end of Pioneer Canal is simply ditch which evidently was started from plow furrow or something of that sort and now looks as if it had cut its own channel to river. It crosses railroad in a culvert. After it passes railroad right of way there is not much appearance of ditch.

Referring to Exhibit S-4, there is no fence along north line of Section 14-15-74. There is a fence, however, running east and west immediately north of area which I found in alfalfa. This is about 600 feet south of section line. Alfalfa field on plane table
4252 sheet runs to fence. If plane table survey mistook fence for section line, thinking fence was on section line, there would be discrepancy of general size of alfalfa tract between my survey and one shown on plane table survey. Fence on east side is entirely different. There is material difference in two areas. Both in shape and size. Principal difference in shape is on east side of tract. Fence on east side runs due north and south according to my survey. According to plane table sheet, it runs northwest and makes entirely different appearing field. There is no fence running northwest in my survey along alfalfa. I am looking at my survey. There is one running northeast but not northwest.

Do not know when land in northeast corner of section was
4253 plowed. It was plowed previous to 1913. Was working on this section last season and built Grave Ditch which drains Alkali Lake and crosses this plowed land in northeast corner. Do not think this piece was referred to in direct examination.

There is practical discrepancy between plane table survey and my survey of oat field on my Exhibit S-2 and sheet 14 of plane table. That error, if error, was not in favor of Colorado. Outline of tract is just same on plane table survey as I found it except in making allowance for difference in size of two sheets.

Z. E. SEVISON.

Redirect examination by Mr. John D. Clark:

4253 The Popp and Pahlow ("Barlow") Ditch, designated on Sheet 2 of the Defendants' plane table survey was simply
4254 located at the bridge on the county road and probably on the north line of the section and sketched in between, apparently without any view of the ditch between those points. The land below the Popp and Pahlow Ditch in Sec. 22 marked on my map as irrigated pasture, 16.3 acres, is irrigated from that ditch. I had never seen the plane table survey map prior to my examination this afternoon, and was directed to make a survey to ascertain the location of certain definite objects and did not have in mind any location made by the Colorado engineers.

Recross-examination by Mr. Fred Farrar:

I did not know that lands lying north of county road were not covered by actual survey but were simply sketched in from a very superficial survey.

JAMES M. HOGE.

Direct examination by Mr. N. E. Corthell:

4255 On my farm and the neighboring farms in the South Platte Valley in Colorado, some native hay is raised; also some native grass land is irrigated and used for pasturage purposes. The methods of handling water for such irrigation are very similar to the methods on the Laramie Plains in Wyoming, where I irrigated quite a large extent of similar lands; and was also familiar with the methods used by other ranchmen in similar work. In giving the production of crops on my Wyoming farms, I did not give those in
4256 Township 15, where the results were generally good. I sold forty tons of oats one fall at $1.80 a hundred, which was about half of the crop produced. It was very heavy grain; very good oats; equally good, I think, with crops grown or seen by me in Colorado and other places.

4256 Cross-examination by Mr. Fred Farrar:

Land both north and south of farm I now occupy is irrigated for pasture in Colorado. It is river bottom land. This river bottom

land is natural hay land. Unless ground is rough the hay can be cut.

E. D. TITUS.

Direct examination by Mr. John D. Clark:

4257 I am familiar with Sec. 36, Tp. 14, R. 77, near the headgate of the Pioneer Canal (in Wyoming). Referring to the map, Exhibit S-1, the location of the ditches, fields and roads shown is correct. There is an alfalfa field as shown on this section between the Murphy Ditch and the Pioneer Canal. It has been there ten or eleven years, and last year stood more than two feet in height and is easily observable by anybody making any sort of an examination of the land. People have remarked to me about the large growth. The Murphy Ditch as shown on this map has been
4258 there beyond my memory, and is entirely separate from the Sodergreen High Line. The road shown is also correctly shown.

I farmed Sec. 14, Tp. 15, R. 74 for quite a number of years, and built the fences that cross the interior. Exhibit S-4 correctly shows the location and shapes of the fields and the location of the fences and ditches. I ran the lines around the different tracts to find out the exact acreage as required by a contract I had with the people owning the land. I built the waste ditch crossing the northwest corner and again entering the section in the south half about eight or nine years ago to carry waste water in time of storm to the river from the Pioneer Canal. It has been in constant use and
4259 can be easily seen by anybody making an examination of the land and will carry 35 to 40 second feet of water. It is about six feet wide on the bottom. This ditch is an artificial ditch extending across the Wolcott ditch to an old river channel. The fence on the south boundary of the meadow is about 1000 feet south of the center line of the section. There is no fence located near the center of the section as shown on the plane table
4260 survey. The alfalfa field shown on the Sevison map in the north half of the section is not entirely in the N. E. ¼ of the section as shown on the Colorado plane table survey map, but extends into the N. W. ¼ 300 or 400 feet, maybe more. The nearest east and west fence is about 600 feet south of the north line of the section. I measured from the quarter rock down to the land I plowed, and afterwards put into alfalfa. The fence lying west of the north and south center line of the section does not reach to the north line as shown on the plane table survey. It lacks about 600 feet. The north and south fence in the east half of the northeast quarter runs due north and south as shown on Sevison's map. That is the only fence that has been there to my certain knowledge in the last twenty-five years, and there is no fence corresponding to that shown by the plane table survey. I built the fences in that
4261 section myself. Have measured with a chain the oat field on Sec. 16, Tp. 15, R. 74 and found a trifle over 40 acres. The same field shown on Sevison's map S-2 as 43.6 acres. The Sevison

map, Exhibit S-3, correctly shows the ditches, fences and fields on Sec. 22, Tp. 14, R. 76, including the sizes and irrigated areas. There is an alfalfa patch lying immediately below the Parker Ditch and east of the oat field, not shown at all on the plane table survey map of this section, where it is marked meadow land, the location also being different. The plane table survey map does not re-
4262 semble the tract of land at all. The Bloom lateral of the Pioneer Canal crosses this section as shown on the Sevison map. It is about four feet wide on bottom and about sixteen inches in depth, and irrigates land above the Parker Ditch as shown on the Sevison map. The ditch is not shown on the plane table map, which is also incorrect in its symbols designating this land as unirrigated pasture land. The Popp and Pahlow Ditch enters this section but is not correctly shown on the plane table map. The Parker Ditch is also incorrectly shown, having no reverse curve as indicated on the plane table map. The meadow extends to the Popp
4263 and Pahlow Ditch beyond the boundary indicated on the plane table map and into the E. ½ of the E. ½ of the section, containing about 15 or 20 acres which was cut over in 1912, and I think in 1913. There is a waste ditch extending from the end of the Pioneer Canal to a slough about 1000 feet from the river. It is more than a mile and half in length in a direct line but winds around. After it passes the railroad track and strikes the flatter ground, it is eight feet on the bottom and two feet in depth, that portion being built about five years ago. The slough runs into the river.

4264 Cross-examination by Mr. Fred Farrar:

Alfalfa on Section 36 as shown on my Exhibit S-1 is about 3 or 4 inches high at this time. I was up there on the 12th of present month and it was showing up nicely then.

Referring to Exhibit S-4, I constructed fence about 600 feet south of section line and north of alfalfa. I knew I was not constructing it on section line. So constructed it because it was adjoining other land I had put into cultivation and I didn't want to separate them from other lands. Section is not fenced on north. The land is open up to county road. It is fenced in quite a large field. There are about 2000 acres that I leased.

4265 Referring to Section 14 shown on Exhibit S-4, the waste ditch which I have described after it passes Wolcott Ditch is in an old riverbed from 20 to 30 feet wide. Channel is cut. This map does not show it.

My statement exhibits are correct is from general knowledge of areas and from measurements I made myself. I made measurements of land that was irrigated under Bloom Lateral which is owned by other parties. Mr. Watson owns land at present time. I made no measurements on Exhibit S-1. On Exhibit S-3 I measured land irrigated several years ago by a man by the name of Heffron who owned certer of Section 22 this represents. I don't believe I measured all of areas shown on sheet. Did not run
4266 out ditch lines.

R. I. MEEKER.

Direct examination by Mr. John D. Clark:

4266 I assisted Sevison on some of the surveys during the past three weeks upon certain sections to ascertain the location of fields and ditches on the Laramie Plains, including the Watson Ranch and adjacent lands in Sec. 22, Tp. 14, R. 76; Sec. 36, Tp. 14, R. 77 and the survey of the Carroll Lake and Alsop Lake and inspection of seeped waste lands in the vicinity of the Bath and Alsop Ranches, and am familiar with his maps of these surveys, which correctly represent conditions as we found them. Have not checked his areas. Have been familiar with the alfalfa field in Sec. 36, Tp. 14, R. 77 shown on Exhibit S-1 for two seasons and saw alfalfa cut from it in 1912 and 1913. The Murphy Ditch is one of the
4267 oldest ditches on the Laramie River and I have seen it diverting water which was applied on the underlying land in 1912, 1913 and 1914.

Exhibit S-3 correctly designates and shows the irrigated area in Sec. 22, Tp. 14, R. 76, known as the Watson place. The Bloom lateral extends across that section. The source of the water supply on that section is the Bloom lateral of the Pioneer Canal. Some lands under the Parker Ditch are irrigated by seepage from the latter ditch. Water from the Bloom lateral is carried over the Parker Ditch by flumes which would be observed if they
4268 followed the laterals. The Colorado plane table survey is in error in classifying lands in Sec. 29, Tp. 14, R. 76, lying South of the county road as pasture land, unirrigated, since, practically all of that land lying under the Popp and Pahlow ("Barlow") Ditch is irrigated. I saw water applied there in 1912, 1913 and 1914; approximately 130 acres which is not credited as irrigated land. The Sodergreen Lake is incorrectly shown, being really located in Sections 21 and 28 instead of wholly in Section 28. The Pioneer Canal and Pioneer Canal Enlargement and Lake Hattie Supply Canal No. 1 are incorrectly shown since the Enlargement discharges water directly into the Sodergreen Lake, and the Pioneer Canal and Lake Hattie Supply Canal No. 1 draw their water from the bifurcation structure at the lower end of the lake. There is a waste ditch from the Pioneer Canal known as No. 1, located several miles above Laramie and another known as No. 2 at the end of the Pioneer Canal, both of which discharge directly into the
4269 river. I have known these since and including 1912, having visited them every year. A drain ditch was constructed in the summer of 1913 by Mr. Buntin in Sec. 14, Tp. 15, R. 74. I believe before the Colorado plane table survey of that section. I have also observed a number of other small drainage ditches and recall one on the Sodergreen Ranch along the base of the bluff directly south of the Sodergreen Lake under the Parker and Popp and Pahlow Ditches.

Cross-examination by Mr. Fred Farrar:

Drain ditch constructed by Mr. Buntin was not a completed ditch at the time I made survey of that area. Think I heard greater portion of Mr. Woodhall's testimony for Colorado.

Referring to Exhibit S-1, I recall fact that Mr. McAnelly and Mr. Woodhall testified that it was impossible to make plane table survey of all of area, and that everything north of county road was
4270 sketched in from superficial survey. Do not recall exact commencement of plane table survey. It was my understanding that some work had been done on Section 36 and I recall having seen plane table party out at work in adjacent section, Section 31-14-76. I did not understand Mr. McAnelly when he testified that when he first began survey he did not make classification which he termed irrigated pasturage. I understood that testimony was introduced to effect that he did not make classification called irrigated pasturage.

The 130 acres in section 29 designated pasturage, as I understand from testimony introduced heretofore, is represented as dry non-irrigated land. According to legend shown on sheet one and other sheets that land is classified by Colorado as non-irrigated
4271 Sodergreen Lake and bifurcation works of Lake Hattie inlet lie north of county road.

Waste Ditch No. 1 of Pioneer Canal is used to regulate flow of water at times of rainfall when excess water came into canal. There is excess water occasionally from heavy rains. There are times when canal has to be regulated by closing headgates and that would tend to throw surplus down canal and in order to keep it from overflowing at lower end, it is advisable to waste some water through waste ditch No. 1. It is not quite midway along canal.

R. I. MEEKER:

Redirect examination by Mr. N. E. Corthell:

4271 Waste Ditch No. 1 of the Pioneer Canal carries the water to the Laramie River but the term of "waste" is not used to indicate that the water is lost. I am familiar with the testimony of John E. Field relating to the flow of the water in the
4272 Laramie River and with the defendants' Exhibits 125-129; 143-145 in connection with the same. Those tables do not represent Mr. Field's own measurements or observations, but are existing hydrographic records secured in past years by the U. S. Geological Survey, the State of Wyoming, and the State of Colorado. I assembled all the hydrographic records on the Laramie River prior to the commencement of the court work and spent a large amount of time on them at intervals during several months. Since the giving of Mr. Field's testimony, I have reviewed the data, assembled it, compared it, and noted the relation of results at the stations and analyzed a large portion of the records, re-
4273 plotting the discharge curves and making new rating curves, and working out daily means and monthly totals and annual

runoff, continuing the records down to this time, May 15th inclusive, 1914. I am familiar with the general practice and methods used in measuring streams and recording flow, and have had about fourteen years' experience in measuring streams and in computing data and in analyzing data secured by others, and I am familiar with the methods of measurement and sources of records in the State Engineer office of Wyoming and Colorado and the U. S. Geological Survey, having spent several years with the survey in Colorado and adjoining states, measuring streams and canals and in that work and related work, since which time I have had occasion to go into the records both in Wyoming and Colorado. The accuracy of stream records depends first on the natural conditions at the gauging station, and secondly, the methods and care used in securing those data. The greatest and most common errors that occur in stream measurement are usually caused by incorrect soundings, which invariably give too great a cross section, especially in high water measurements. The reasons are that in making soundings the weight in streams which have rock beds sinks into holes between the rocks or the weight and lines are carried down stream to a point not perpendicular to the cross section, giving soundings which are too great. Errors also occur from lack of keeping the meter
4274 point clean and sharp to avoid increased friction. If not well oiled and in good condition, the velocities secured are below their true values and the measurement is less than the actual volume of water. At times on mountain streams the velocities of swift currents can only be secured on the surface when a co-efficient is required for the reduction to a mean velocity. Such co-efficients are based on experience and judgment is needed in their application. The tendency of all high water measurements both from sounding and velocity factor is to secure too high results, as disclosed by an examination of the older and earlier records, which being from high water measurements, are usually in error and give results far too great. Errors also occur from the settlement of the gauge, and unless frequent checkings of bench marks are resorted to, these errors may cover a considerable length of time, giving a gauge reading which is too high and therefore showing more water than actually passes. Errors frequently occur from careless readings of the gauge or from neglect and faking of the records. The time of day at which gauge height observations are taken may not give a true mean for that day, especially on mountain streams, where the daily tide is pronounced. In case automatic stage registers are used, it is very important that the pen be checked with the staff gauge each time the chart is changed, and proper notations be noted on the sheet in order that corrections may be made. Errors also occur in measurements at time of high water from rising and falling stages. Back water from dams, drift or other things frequently vitiate the results for short periods. Ice conditions
4275 are an important factor and the direct application of discharge measurements based on open channel conditions and applied to gauge heights secured when ice conditions obtain, give result too large. This is also true of obstructions of channels by

driftwood or otherwise. Numerous instances have come to my notice of stream measurements in the west where the winter records are practically of no value, being grossly in excess of the actual run-off. This has been confirmed by the more efficient methods of today and greater care used that a sufficient notation as to conditions during the time observations were secured. The errors in the field in making stream measurements are not the only ones. Errors frequently occur in computation, and especially so in the extension of the discharge curve beyond known points of measurement to cover high water. In such case the error is usually positive. In summation then, the accurate measurement of stream flow with current meters is not a mechanical operation which can be performed by indiscriminate and inexperienced persons but requires experience and judgment, not only in the field, but for the proper application and computation of the data secured. Errors in stream measurement preponderate in the positive direction. Most of the records of stream flow secured in the Laramie River basin are based on daily gauge heights of staff gauges made morning and evening.
4276 However, within the last three or four years, automatic water-stage registers have, in a measure, replaced the staff gauges and the later data should be of much more value than the older data which is based on two readings per day of staff gauges. Practically all the stream flow data used by Mr. Field outside the Glendevey and Colorado-Wyoming line stations for 1912 and 1913, and data secured by the Laramie Water Company in the latter part of 1912 and in 1913 and 1914, are from staff gauge readings, while practically all the Laramie Water Company's data are based on automatic water stage register records, the exceptions being the records of 1912 at the Pioneer Dam and the Lake Hattie Supply Canal No. 2 Dam, based on staff gauge readings up to about the middle of August. Since that date automatic water stage registers have been used continuously winter and summer. This is also true at the McGill and Lookout stations on the Laramie River. The data secured at Two Rivers Station was based on staff gauge readings prior to April, 1914. At the present time the gauging stations on the Laramie River and Little Laramie River, with the exception of the May's Ranch Station on the Little Laramie and the Wheatland Station on the main stream are equipped with automatic stage registers, some of them
4277 owned by the State of Colorado, others by the Laramie Water Company, others by the State of Wyoming, and others by the Wyoming Development Company. The Glendevey and State Line Registers were installed late in the season of 1911 by hydrographers from the Colorado State Engineer's office, who supervised the operation of them but local people at times have been used to change the charts. They were installed prior to Mr. Field's administration. There is nothing in the record to indicate that he personally had anything to do with maintaining them, or that Prof. Carpenter had anything personally to do with the installation or reading of the measurements. From an examination of the records, no measurements have been made by Mr. Field and in only a few instances was Mr. Carpenter present during measurements and at no time as

I recall, did he manipulate the meter in person, although he supervised it in a few instances at the Colorado-Wyoming Station
4278 and two or three other stations. I refer to the records of State Engineer's office of Colorado and the hydrographic records secured by Prof. Carpenter in 1912 and 1913 on the Laramie River. He permitted me access to his records and I made copies of those that were needed for computation and notes of others. Mr. Field used those records with other records obtained by the State and also by the U. S. Geological Survey, and the State of Wyoming. I found some large errors in the old records on the Laramie River at the Woods Landing Station. In years where records were secured during the winter, the flow is grossly exaggerated, due to observations when there was ice interference, no discharge measurements being made under those conditions. The application of the discharge measurements made in open channel conditions or during the
4279 summer therefore gives volumes of water enormously greater than actually passing. Generally the months of December, January, February, March and part of April would be affected by these conditions, as the ice does not pass out of the river at Woods Landing until about April 5th to 15th. There are, of course, exceptions in years of earlier springs. The resulting record showed too large a discharge during the winter months. I also found some errors in the high water records, in one instance where they were under-estimated and in another instance over-estimated. These errors were so great that the data cannot be accepted without a careful analysis and re-working. In some instances I was unable to secure the basic data of the earlier years at the Woods Landing Station, either discharge measurements, cross section, notes, or other data, and could not re-compute with any certainty the volumes of water during those years. In my opinion the modifications and final estimates of Mr. Field in dealing with these previous records contain some large errors which vitiate them. I could not modify the records which I have myself secured, because they have been made under known conditions with hydrographic methods of much greater efficiency and accuracy than those secured in the early days, and
4280 the uncertainties due to ice conditions and other factors are eliminated. I have taken all the measurements made at the Colorado-Wyoming line by the State of Colorado, the U. S. G. S. and Prof. Carpenter during the years 1911, 1912 and 1913, and analyzed them by area and velocity curve methods, and thence deduced a discharge curve of area and velocity curves, which are factors of that discharge curve which show his high water measurements have areas greater than the standard cross section and mean velocities in excess of the mean velocity curve for that station. The result is that the application of his discharge measurements with such analysis gives too great a discharge by a good many thousand acre feet during the high water period of the Laramie River, the elemental errors of his measurements being too great a cross section area and too high mean velocities. The cross section areas are accounted for by the fact that soundings were made during high water measurements, and the standard area curve was not used for this station,

and the excess mean velocities were evidently the result of not using a stay line or wire to suspend the meter and decrease the force of the current, and insufficient weights. Prof. Carpenter found three culvert channels other than the main channel, which were carrying
4281 water at extreme high water stages. I do not know just how he applied the water passing through those culverts, but I assume that he made a rating curve for the channel and then for those gauge heights where water passed through the culverts he added values to the rating table securing a total to represent the entire flow. I prepared a discharge curve as I indicated, taking all the measurements mentioned and those made by myself, and from this curve, deduced a rating table applicable for the high water discharges of the year 1912. A discharge curve is a graphic method of interpreting discharges for all gauge heights at a record station. To plat a discharge curve it is necessary to assemble the measurements which have been made, and plot these on a cross section paper using gauge heights as ordinates and discharges in second feet as abscissa. The curve is then thrown through the known points meeting that condition which represents the mean curve of all the measurements. Mathematical equivalents are then taken from this discharge curve for the various gauge heights. This is the rating table and its application to the daily mean gauge heights gives the daily mean discharges of that particular station. The sheet offered (exhibit T-1) represents a record in the manner indicated of all the
4282 water measurements and velocities recorded at the Wyoming-Colorado line and the curve has been extended to conform to the area and velocity measurements. The curve so established is the curve which is applicable for the years for which these measurements were made and established for the high water discharges of 1912. Other curves could be constructed, based on a standard cross section, and the area and velocity factors. That curve represents the best practice in hydrographic engineering. A standard area curve for a discharge station which has a permanent cross section is secured by taking careful soundings during low water periods or level observations and extending these level observations up to and above the high water mark. From these data the areas are computed each half foot on the gauge. These points are then platted and the standard curve is drawn in. This curve is usually less than the area curve deduced from measurements made by soundings at high water and other stages for the reasons indicated. The table
4283 produced (Exhibit T-2) is the mathematical equivalent of the graphic. The table (Exhibit T-3) shows the discharge of the Laramie River at Boswell's Ranch on the Wyoming-Colorado state line for the year 1912 as determined by the curve and rating table just introduced, using the gauge heights of the State Engineer's office of Colorado published and on file in that office, being the same data used by Messrs. Field and Carpenter in the tables prepared for Colorado.

(Copy of Complainant's Exhibit T-3.)

Laramie Water Company, Laramie, Wyoming.

Daily Mean Discharge of Laramie River at Bowell's Ranch (Revised by Mecker), Near Jelm, Wyoming, for the Year 1912.

Drainage Area, 312 Square Miles.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	....	....	....	....	115	1,395	1,175	290	92	92	82	
2.....	....	....	....	....	128	1,490	934	214	82	92	82	
3.....	....	....	....	....	141	1,890	813	198	82	103	72	
4.....	....	....	....	....	115	2,200	775	183	72	115	72	
5.....	....	....	....	....	103	2,200	853	154	62	115	72	
6.....	....	....	....	....	82	2,200	701	154	72	103	72	
7.....	....	....	....	....	103	2,080	596	141	62	103	72	
8.....	....	....	....	....	141	1,890	534	198	62	103	52	
9.....	....	....	....	....	168	1,890	564	168	62	92	72	
10.....	....	....	....	....	168	1,890	534	141	72	103	82	
11.....	....	....	....	....	168	1,600	534	128	82	92	62	
12.....	....	....	....	141	183	1,395	630	115	72	82	43	
13.....	....	....	....	115	198	1,395	665	115	72	72	43	
14.....	....	....	....	82	214	1,310	701	103	82	72	62	
15.....	....	....	....	62	232	1,075	596	115	92	72	62	
16.....	....	....	....	52	270	893	534	141	103	82	43	
17.....	....	....	....	62	330	775	478	128	103	92	36	
18.....	....	....	....	72	376	701	451	115	103	92	52	
19.....	....	....	....	92	478	665	425	103	115	103	72	
20.....	....	....	....	82	564	665	478	103	141	92	72	
21.....	....	....	....	62	596	701	400	92	103	62	43	

Copy of Complainant's Exhibit T-3—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
22.....	....	....	....	43	665	775	352	82	92	72	52		
23.....	....	....	....	36	738	893	330	92	103	82	52		
24.....	....	....	....	72	813	1,025	330	82	92	72	52		
25.....	....	....	....	72	893	1,075	290	82	82	82	52		
26.....	....	....	....	72	1,075	1,025	290	72	92	92	43		
27.....	....	....	....	72	978	1,175	310	62	103	103	36		
28.....	....	....	....	72	813	1,235	270	72	92	82	36		
29.....	....	....	....	92	934	1,175	232	82	92	82	36		
30.....	....	....	....	103	1,490	1,125	232	92	92	82	36		
31.....	....	....	....	....	1,735	....	290	103	....	82	....		
Total...	....	....	....	1,456	15,007	39,803	16,397	3,930	2 628	2,765	1,715		Year period.
Mean...	....	....	....	76	484	1,327	526	127	888	89	57		
Run-off Acre feet.....				2,864	29,760	78,962	32,342	7,809	5,236	5,472	3,392		165,837

Discharges applied by H. W. C., 4/18/14.
Checked by R. I. M., 4/20/14.

(COPY OF COMPLAINANT'S EXHIBIT T-4.)

Comparative Table.

1912 *Run-off of Laramie River at Colo.-Wyo. Line, Boswell's Ranch.*

Values in Acre Feet.

	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Total.
Published 16th Biennial Report, Colo.....	2,713	30,034	74,097	33,388	7,367	4,863	5,121	3,290	169,873
Revised by Engineer Field.....	2,830	32,783	92,912	34,087	7,545	5,078	5,343	3,405	183,983
Revised by R. I. Meeker.....	2,864	29,760	78,692	32,342	7,809	5,236	5,472	3,392	165,837

NOTE.—The published data of Colorado did not include water which passed around the gauging station through three culverts during high water.

The revised data by Engineer Field includes water passing through culverts measured by L. G. Carpenter. The Colorado revised data are not based on area velocity curve analyses. For this reason the upper portion of the discharge curve for extreme high water gives too great a discharge.

The revised data by R. I. Meeker are based on area and velocity curve analysis, using a standard area curve and measurements for years 1911, 1912, and 1913.

R. I. MEEKER.

May 19, 1914.

Exhibit T-4 is a table showing a summary of the flow in acre feet at the state line as determined from the same data, and given in three different series that are indicated in the table itself; first, the published data in the 16th Biennial report of the State Engineer of Colorado; second, the same data as revised by State Engineer Field in his testimony in this case; and third, the same data as revised by the witness at the present hearing using the discharge curve and rating table, and discharge table just put in evidence; and these are simply different methods of arriving at the same result and using the same gauge heights and records. From
4284 this it appears that the published report of the State Engineer of Colorado gives the flow of the Laramie River at the state line in 1912 in round numbers: 160,000 acre feet; Mr. Field's testimony, 183,000 acre feet; the calculation of witness, 165,000 acre feet, covering the months of April to November inclusive. The explanation of the higher figures computed by Mr. Field
4285 from the measurements and calculations of Prof. Carpenter is that the discharge measurements were not analyzed by area and mean velocity curves and proper weights given to the more dependable measurements as in my method. On April 11, 1914, I took the cross section at the Colorado-Wyoming line from the existing water surface, and also above and below high water line with a level and rod, and then took this data and plotted the actual cross section and determined a standard area curve which can be used at this station for the reason that conditions are permanent with reference to the stream bed in the main channel. The difference between the measurements and computations of area arises from the fact that I made a measurement with level and rod above the water surface, while Prof. Carpenter made his measurements with
4286 a line and weight beneath the water surface and during high water stages. As I recall he also testified in one instance a pipe was used to secure soundings. A cross section of a river channel can be taken with greater accuracy by level and rod than by soundings with leaden weights or through pipe or other means when the water is four to six feet deep. On the curve which I have put in evidence, the areas of each discharge measurement have been plotted to show the general location of the area curve, but no line has been drawn to them. The only line drawn on Exhibit T-1 is the Standard area curve based upon the cross section determined by level and rod, but the location of the line drawn through the areas of the respective measurements is very apparent on account of their closeness. The standard area curve on this Exhibit is determined by my measurements, while the measurements of Prof. Carpenter fall to the right of this curve, giving areas in excess of the standard curve thus showing too great a discharge. (Witness projects an area curve on Exhibit T-1 in a dotted line corresponding to the measurements made by Prof. Carpenter.) The mean velocity curve is shown further to
4287 the right on this sheet, the curve being determined by plotting through the individual mean velocities and taking the curve which would balance with the various measurements made with the

exception of the mean velocities secured by Mr. Carpenter, which are in excess and beyond any of the velocities secured by other hydrographers. I am not clear what measurements were taken as the basis for the location of the curve used by Prof. Carpenter. As I understand, neither he nor Mr. Field analyzed their discharge curve, their areas and mean velocities. Their curve (the dotted line) at high water stages would give too great a discharge, very much
4288 greater than the existing curve in Exhibit T-1. The small triangles in red ink on this chart indicate measurements of Prof. Carpenter in 1912; and my own measurements made in 1913 are indicated by a small green square; and the measurements made in 1911 are designated by a small circle with a black dot in the center; in 1912 additional measurements by other hydrographers are marked by a triangle and dot in black. Measurements in 1913 by other hydrographers, are plotted with a small black square.

Exhibit T-2, column 3, (the 5th column from the left) gives the discharge in second feet for the respective gauge heights for the main channel under the bridge at the gauge station. The next column gives the discharges for the various gauge heights through the culverts at high water stages. The last column (also under figure 3) is a summation of the water passing through the main channel and the water through the culverts, and gives the total discharge at the Boswell Station at high water stages according to Exhibit T-1, the discharge curve and the related data.

Defendants' Exhibit 157 is the graphic equivalent of the hydrographic record secured in 1912, at the station at Filmore
4289 just above the Bellamy Canal on the Little Laramie River. On April 24th, I examined these records in Prof. Carpenter's office. They correspond to the hydrograph and indicate a flow in 1912 of 128,955 acre feet from May 20th to Oct. 19th inclusive; from June to September, inclusive, 117,185 acre feet. The records secured in 1912 by the State of Wyoming at May's Ranch 1½ miles above, also the records secured by the Laramie Water Company at Lake Hattie Supply Canal No. 2 Dam about one mile below the Filmore Station of Prof. Carpenter are comparable with the Carpenter records when corrected by adding the amount of water diverted by Lake Hattie Supply Canal No. 2, and the amount of water diverted by the Bellamy Canal, records of which were secured in both instances, though there are several small ditches which take out a small volume of water between the Carpenter Station and the Lake Hattie Supply Canal No. 2 dam not sufficient to
4290 vitiate the comparison. In extreme high water these small ditches might divert as much as 45 second feet or a flow for the season of approximately 4,000 to 5,000 acre feet. Fair results can be secured at the station at May's Ranch, although the river is in two channels at this station during high water, but there are bridges in there where the measurements can be made directly at the station. The Carpenter station is not an advantageous station for securing dependable results for the reason that it is located at a point above the Bellamy dam where there is no bridge and where high water discharge measurements can not be made. To make

discharge measurements at this station, it is necessary, at low stages, to wade in the vicinity of the station and at high stage it is necessary to go down to the bridges across the several channels at Wright's Ranch and make measurements of each channel, also measurements of the Bellamy Canal, and another small ditch, or measurements could be made at May's Ranch. The station at Lake Hattie Supply Canal No. 2 Dam is the best station for measurements of water on the Little Laramie River in the vicinity of Filmore for the reason that conditions at the dam are permanent, the dam having a weir across and there is a bridge on the Dougherty Ranch about a half mile below where discharge measurements can be made at high water and where they were so made in 1912, and an excellent discharge curve secured based on area and mean velocity analysis. Of course, it is necessary to add any diversions between Bellamy Canal and Lake Hattie Supply Canal No. 2 to be comparable.

4291 The comparative table produced (Exhibit T-5) showing the 1912 run-off at Filmore in acre feet is the result of analysis of the data available at all three stations. I prepared the data at the Lake Hattie Supply Canal No. 2 dam, examining the basic data secured by Carpenter and the basic data secured at May's Ranch, but did not make new computations, taking the computations of the State Engineer of Wyoming at Filmore, the computation derived from Prof. Carpenter's measurements and my own figures at the Lake Hattie No. 2 dam.

(COPY OF COMPLAINANT'S EXHIBIT T-5.)

Comparative Table.

1912 *Run-off Little Laramie at Filmore, Wyoming.*

Values in Acre Feet.

	June.	July.	August.	Sept.	Oct.	Total.
(a) May's Ranch (Wyoming).....	54,300	23,200	7,750	4,440	4,750	94,440
(b) Filmore (L. G. Carpenter).....	76,632	27,676	8,514	4,363	Record incomp.	117,185
(c) Hattie No. 2 Dam (Lar. Water Co.).....	51,073	20,875	5,829	3,761	4,175	85,713
Excess by L. G. Carpenter over State of Wyoming, Period of June to Sep., incl.....	22,332	4,476	764	—77	....	27,495

(a) 1½ miles above Filmore. See 11th Biennial Report, State Engineer of Wyoming, p. 94.
(b) At Filmore, just above Bellamy Canal Dam. See Exhibit No. 157, by Colorado.
(c) Approximately one mile below Filmore; includes water diverted by Bellamy Canal; includes water diverted by Hattie No. 2 Canal.

Several small ditches divert water between the Bellamy Dam and No. 2 Dam. No correction made for these diversions. The results secured by the Laramie Water Company should, therefore, be slightly less than the values secured either at May's Ranch or Filmore, since there is no inflow between the two stations.

May 19, 1914.

R. I. MEEKER.

(COPY OF COMPLAINANT'S EXHIBIT T-6.)

Comparative Table.

1913 *Run-off Little Laramie River at Filmore, Wyoming.*

Values in Acre Feet.

	May.	June.	July.	Aug.	Sept.	Oct.	Total.
(*a*) May's Ranch (Wyoming).....	21,880	23,164	6,366	2,566	1,325	1,848	57,149
(*b*) Filmore (Colorado)	15,987	17,851	2,890	1,217	815	No record.	38,760
(*c*) Hattie #2 Dam (Lar. Water Co.)...	18,600	20,844	4,851	1,870	1,167	1,622	48,954
Deficiency between Colorado and Wyoming, May to Sept., inclusive.....	5,893	5,313	3,476	1,349	510	....	16,541

(*a*) At May's Ranch, 1½ miles above Filmore.
(*b*) At Filmore, just above Bellamy Canal Dam.
(*c*) Approximately one mile below Filmore; includes water diverted by Bellamy Canal; includes water diverted by Hattie No. 2 Canal.

Several small ditches divert water between the Bellamy Dam and No. 2 Dam. No correction made for these diversions. The results secured by the Laramie Water Company should, therefore, be slightly less than the values secured either at Mays Ranch or Filmore, since there is no inflow between the two stations.

R. I. MEEKER.

May 19, 1914.

Exhibit T-6 gives the flow derived in like manner at these three stations for 1913. The records at Filmore in 1913 were secured by the State of Colorado, which had a hydrographer in the field to cover the Little Laramie River last summer.

Defendants' Exhibit 157 was based on the Filmore records for 1912. The Filmore record for 1913 was not put in evidence
4292 by Colorado. The 1912 records secured by Prof. Carpenter are in excess of those secured at May's Ranch for the State of Wyoming for the period from June to September, 27,495 acre feet, probably due to the fact of poorer gauging station, and the difficulty in securing correct high water measurements of the numerous channels passing through Wright's Ranch where they were made. As I recall in some of these high water measurements, the water was passing over the meadow. As there is but one small ditch diverting water between May's Ranch and Filmore Station and no inflow, and the 1912 records at May's Ranch are also substantiated by discharge measurements made in other years, the conclusion is that the volume of water secured at the Filmore Station by Mr. Carpenter is in error 20,000 or 25,000 acre feet. This is also affirmed by the corrected data secured at Hattie No. 2 dam, which agrees in a general way with the data secured at May's Ranch when an allowance is made for the small ditch diversions and the Bellamy dam and Lake Hattie No. 2 dam.

Referring to the 1913 records secured at Filmore by the State of Colorado, I am unable to give a definite explanation of the deficiency of 16,541 acre feet for the period of May to September, inclusive, which occurs between the May's Ranch or Wyoming station and the Colorado station, other than that the data that were secured are based on insufficient discharge measurements or incorrect discharge measurements and a comparison with the data secured at Hattie No. 2 dam shown as the aggregate for the Bellamy Canal, no correction being made for Hattie No. 2 Canal through which no water was diverted in 1913, that the Filmore record is in error ap-
4293 proximately 15,000 acre feet too low. These data secured by Colorado at Filmore Station were not used by Mr. Field in his testimony or discussion of the Little Laramie River run-off, and the fact that Exhibit 131 bears the following notation: "Record for 1913 at Lake Hattie Inlet plus flow in Bellamy Canal by R. I. Meeker" indicates the uncertainties and lack of confidence in the records secured by the State of Colorado. It might be that Mr. Field disregarded this low flow secured by his hydrographer for the reason that it did not show as large water supply available from the Little Laramie River as he could secure by using the Lake Hattie Dam records. The tendency throughout his hydrographic record is to consistently accept the records which give the greatest flow at stations where there were conflicts and to destroy those records which would show a less discharge thereby showing a larger amount of water in the Laramie River basin available for irrigation on the Laramie Plains. A specific instance where he has used my records when they were higher than the Colorado records is at Woods Landing where one of the year's records was too low and he had those

records re-computed and revised, but he ignored another year of those records which, if revised according to the data available, would show a much less discharge than the face value of the rec-
4294 ords. I find no consistent reason why he should have adopted the method of taking the high years and destroying the low years, other than he had decided upon what volume of water was available in the Laramie River basin and made his computations fit the answer. A consistent and careful analysis of these records from a hydrographic standpoint does not permit of any such deductions, and it was because of the uncertainties and errors and unknown conditions under which the old records were secured that after an extended and careful re-computation of the old records at Woods Landing and at other stations, I came to the conclusion that only in a general way could they be taken and not used concretely. They do, in a broad way, mark the yearly run-off if the winter flow records are disregarded and the two or three years which are grossly in error are disregarded. As a result of my analysis of these records and the continuation of my own measurements and records down to May 15, 1914, I have revised and brought down to date the tables of the flow of the Laramie and Little Laramie Rivers used in my former testimony.

(COPY OF COMPLAINANT'S EXHIBIT T-7.)

Laramie River Run-off, 1912, 1913, 1914.

Run-off, 1912.	Acre feet.	Distribution.	Acre feet.
Laramie River at Pioneer Dam, near Woods, Wyo. Run-off Jan. 1 to Dec. 31.	207,000	Pioneer Canal	17,703
		Lake Hattie Reservoir....	69,855
		All other ditches between Pioneer Dam and Two Rivers	29,892
NOTE.—Jan., Feb., and March run-off estimated as 8,300 acre feet.		Wheatland Res. No. 2 and intermediate ditches below Two Rivers.....	89,550
	207,000		207,000

Run-off, 1913.	Acre feet.	Distribution	Acre feet.
Laramie River at Pioneer Dam, near Woods, Wyo. Run-off Jan. 1 to Nov. 30.	109,593	Pioneer Canal	13,504
		Lake Hattie Reservoir....	28,470
		All other ditches between Pioneer Dam and Two Rivers	18,917
		Wheatland Res. No. 2 and intermediate ditches below Two Rivers.....	48,702
	109,593		109,593

Monthly Discharge of Laramie River at Pioneer Dam, Near Woods, Wyoming, in Acre Feet.

	1912.	1913.	1914.	Means for 12 months.
January	.....	2,650	3,283	2,966
February	.....	2,355	3,088	2,722
March	.....	3,296	4,003	3,650
April	5,534	12,674	8,807	10,740
May	40,643	38,307	°13,383	39,475
June	91,874	26,598	.....	59.236
July	34,863	6,825	.....	20,844
August	7,809	3,130	.....	5,470
September	4,641	3,023	.....	3,832
October	6,456	3,812	.....	5,134
November	4.403	3,677	.....	4,040
December	2,644	3,246	.....	2,945
Total	198,867	109,533	32,564	161,054

° 1 to 15, inclusive.

These records secured by the Laramie Water Company.

R. I. MEEKER,
Hydrographer.

May 21, 1914.

(COPY OF COMPLAINANT'S EXHIBIT T-8.)

Little Laramie River Run-off, 1912, 1913, 1914.

Run-off, 1912.	Acre feet.	Distribution.	Acre feet.
Little Laramie River at Hattie Supply Canal No. 2 Dam, near Filmore, Wyo., plus volume diverted by Bellamy Canal. June 1 to Dec. 31	68,874 24,793	Bellamy Canal and James Lake Reservoir	24,793
		Hattie Supply Canal No. 2.	14,053
		Ditches between No. 2 Dam and Two Rivers	17,245
		Wheatland Reservoir and intermediate ditches below Two Rivers	37,556
	93,667		
	93,667		93,667

Run-off, 1913.	Acre feet.	Distribution.	Acre feet.
Little Laramie River at Hattie Supply Canal No. 2 Dam, near Filmore, Wyo., plus volume diverted by Bellamy Canal. Jan. 1 to Dec. 31	47,327 12,310	Bellamy Canal and Lake James Reservoir	12,310
		Hattie Supply Canal No. 2 Ditches between No. 2 Dam and Two Rivers	222,254
		Wheatland Reservoirs and intermediate ditches below Two Rivers	25,073
	59,637		
	59,637		59,637

Monthly Discharge of Little Laramie River at Hattic Supply Canal No. 2 Dam, Near Filmore, Wyoming, in Acre Feet.

	1912.	1913.	1914.	Means for 12 months.
January	.....	1,045	1,230	1,138
February	.....	1,000	1,277	1,138
March	.....	1,476	1,439	1,458
April	.....	3,909	3,451	3,680
May	.....	14,142	°3,033	14,142
June	42,147	15,590	.....	28,868
July	13,558	3,431	.....	8,494
August	3,911	1,353	.....	2,632
September	3,701	1,107	.....	2,404
October	1,697	1,562	.....	1,630
November	2,702	1,642	.....	2,172
December	1,058	1,070	.....	1,064
Total	68,774	47,327	10,430	68,820

° May 1 to 15, inclusive.

NOTE.—Run-off of Little Laramie River included and accounted for in storage tables of Laramie River Basin for 1912 and 1913.

R. I. MEEKER.

May 21, 1914.

The table (Exhibit T-7) is intended to supersede Exhibit I in my former testimony and the table Exhibit T-8 is intended to supersede Exhibit J in my former testimony. These two tables now
4295 introduced include a summary of all the data I have of the flow of these two streams obtained from my personal measurements and observation, secured under the most advanced hydrographic methods and under known conditions, and brought down to date. The Laramie River record extends from April, 1912, to May 15, 1914, inclusive, and the Little Laramie table from June, 1912 to May 15, 1914, inclusive. The total run-off of the Laramie River at the Pioneer dam in 1912 was 207,000 acre feet; in 1913, 109,593 feet; the mean of these two years was 161,054 acre feet. The Little Laramie run-off for 1912 is 93,667 acre feet; and for 1913, 59,637 acre feet; the mean, 68,820 acre feet. The means are
4296 based on two years' records on the Big Laramie for all months, and on the Little Laramie the mean for the month of May is based solely on the run-off for May, 1913, since the May, 1914 records were not used in determining the mean, as they cover but fifteen days. The mean annual run-off is the summation of the monthly mean run-off for twelve months in each year. Based on review of the flow records taken in a general way, and other hydrographic information, I have concluded that the year 1912 was slightly above normal in the Laramie River basin, and that, roughly, the normal at the Woods Landing station or Pioneer dam is approximately 200,000 acre feet, the year 1913 being a trifle above 50% of normal.

I have prepared a table from the U. S. G. Survey records taken at Saratoga, Wyoming, covering the run-off of the North Platte

River, covering the years from 1903 to 1906, inclusive, 1909, 1912, 1913, inclusive, for the months of April to October, being all the records available. I am familiar in a general way with the
4297 conditions affecting the flow of that stream. The drainage area above the Saratoga station is very similar to that of the Laramie River basin, being mountainous and being adjacent to like forestization and similar climatic conditions. Both basins are rimmed by high mountains, a portion of which lies between the two basins and is common to them. Both streams flow in a northerly direction, in general parallel with each other, and about 80 miles apart—in the upper portions approximately 20 miles apart.
4298 Both drainage basins have a northerly exposure and I consider the physical and climate conditions similar, more so than the similarity between the Laramie River and the Poudre River. The Laramie and North Platte, based on the physical features of the drainage basins, would be more likely to correspond in the fluctuations of their annual flow than the Laramie and the Poudre. The records on the North Platte and the Laramie River are hardly simultaneous enough to draw an absolute deduction, but only permit general conclusions. I think the table prepared would be valuable as an indication of what was the probable relative flow on the Laramie River for 1912 and 1913 as compared with other years shown on the North Platte.

(COPY OF COMPLAINANT'S EXHIBIT T-9.)

Daily Mean Discharge of North Platte River, Near Saratoga.

Records of U. S. G. S.

Year.	April.	May.	June.	July.	August.	Sept.	Oct.	Total.	Per cent.
1903.....	a91,792	a269,999	a411,111	77,905	27,423	35,225	40,705	954,161	96.1
1904.....	88,070	295,900	320,400	82,390	30,680	19,760	23,060	860,260	86.6
1905.....	56,650	204,700	417,700	86,330	26,440	13,450	18,380	823,650	82.8
1906.....	99,400	291,000	337,000	123,000	33,400	29,900	28,300	942,000	94.8
1909.....	78,000	360,000	768,000	319,000	87,300	60,100	31,400	1,703,800	172.0
1911.....	a91,792	234,000	320,000	78,100	18,600	12,400	31,200	786,092	79.4
1912.....	69,000	250,000	497,000	196,000	54,200	36,100	42,100	1,144,400	115.5
1913.....	159,632	254,392	217,677	40,089	17,323	15,521	26,976	731,610	73.7
Total...	734,336	2,159,991	698,888	1,002,814	295,366	222,457	242,121	.....	.....
Mean...	91,792	269,999	411,111	125,352	36,921	27,807	30,265	993,247	.....

a Mean of actual records used for missing months to complete April to October record.

H. W. CAREY.

April 18, 1914.

4299 Table Exhibit T-9 (Table offered in evidence for the purpose of establishing the relative percentage of the run-off for the normal year and primarily to offset the introduction of the Poudre table and the deductions of Mr. Field.)

According to this table, the flow of the North Platte for 1912 was 115.5% of the average flow for the eight years shown by the record, and for 1913, 73.7% of the average for the eight years. I do not know of any better basis from which to determine the percentage of the average flow of the Laramie river for these eight years.

4300 From an examination of Prof. Carpenter's field notes, records and data relating to the measurements made by him or under his direction on the Laramie River, and its tributaries, practically all measurements were made by A. P. Maury and Louis Carpenter. Occasionally the Professor was present, but only in a few instances, judging from the notations in the field books. The notes on the various discharge measurements were insufficient to determine definitely just how they were made. The statement was made to me that they were all secured by the vertical integration method, but the field notes contain no notations as to how they were secured. I would say they were insufficient notes whereby one could probably valuate them. As a whole, I believe them to be fair hydrographic records, but there is an absence of notes in places whereby I could not tell how much confidence to put in them. Of course, there are exceptions, for example, as to the measurements which I did analyze carefully at the Colorado-Wyoming line and found them to give too great discharges, and also on the Little Laramie River at Filmore, which were obviously in error, showing

4301 too great discharges. I took all measurements made at stations on the Laramie River and plotted them on discharge curves derived from my own measurements and found variations in places and especially the tendency was for the high water discharge measurements to give results too high. The low water measurements checked reasonably close, but the discharge measurements on the Little Laramie did not check during high water stages with the flows determined by either the State of Wyoming or the Laramie Water Company. I examined the Bristol Register Charts of the Colorado-Wyoming station for 1912 and 1913 on file in the State Engineer's office with especial reference to the charts covering the high water records of 1912, and also with reference to the condition of the pen, and its variance with the staff gauge during high water stages, and the correction made by Prof. Carpenter. The 1912 Bristol chart records are the poorest that I have had occasion to review. The 1913 records are in much better shape. In 1912 the pen was only corrected upon visits by the hydrographer, the observer simply changing the chart and perhaps with one or two exceptions, making no notation of what the staff gauge registered when the chart was removed. For this reason the records were open to grave suspicion since during 1912 the pen was in error frequently, and especially so during May and June. At one time there was a variation of one foot between the pen and staff gauge. From the record the pen appears to have been very sluggish and distinct daily waves

are not marked on the chart, such as I have observed at the
4302 station at the Pioneer dam in 1913 and 1914. In 1913 the State Engineer's office secured two sets of records, one from the Bristol Register charts and one with morning and evening observations on the staff gauge. This may have been for the reason that the 1912 data were in such poor shape. This register uses chart No. 817 which is only graduated to the nearest two-tenths of a foot interval and in taking gauge heights from the chart it is ultra-refinement to determine them closer than the nearest ½ tenth of a foot. The daily mean gauge heights as determined from the charts are entered on the chart on the respective date, but there is no note indicating who made the computations or who checked them. Some of the charts have no entry as to who changed them, but from information secured at the State Engineer's office and also from conversation with Mr. C. D. Oviatt, who has at times changed charts at this station, the charts have been changed both by Mr. Oviatt and Mrs. Oviatt. In conversation with Mr. Oviatt I found that he had no written instructions to make entries of the staff gauge reading when the chart was removed, and since they were not made whenever the pen was in error, no record is available for correction. He did have verbal instructions not to adjust the pen. The record for May 11th to 17th is missing. On May 16th the gauge rod registered 1.85 feet according to notation, and the pen .095 feet. On May 20th, the gauge rod registered 2.5 feet and the pen 1.5 feet, a very poor record. On May 26th the gauge rod registered 3.2 feet, the pen 2.1 feet; May 29th, the rod registered 3 feet, and the pen 2 feet. A notation occurs of a correction of one foot by L. G. Carpenter at 7:30 P. M. June 1st the gauge height registered 3.3 feet, and the pen 3 feet; on the chart of May 24th to 31st
4303 occurs the following notation: "Records on gauge got moved by crumpling of chart on May 11th until corrected on May 29th. Recorder is working properly but is too low by about one foot. Turner." June 1st the gauge rod registered 3.3 feet, and the pen 3 feet. The chart was removed June 10th, but there was no reference to the staff gauge reading. June 11th, the pen was corrected. .3, but no note showing who corrected it. On the chart of June 17th to 24th no note appears with reference to the staff gauge reading. The chart of June 24th to July 1st shows no notation of staff gauge reading. The 1913 Bristol Register charts are in much better shape and show frequent notation of correction by T. R. Grieve, the hydrographer who covered that portion of the river The 16th Biennial Report of the State Engineer of Colorado contains the following statement relative to gauge station near Boswell, Wyoming:

"This station established August 20, 1911, the equipment consists of a vertical staff gauge and automatic gauge. The automatic gauge was installed July 14, 1913." An examination of this Biennial Report and the 15th Biennial Report disclosed that there are no published records for 1910. T. R. Grieve, chief hydrographer of Colorado, states that the reason for this was that C. D. Oviatt was employed to read the staff gauge in 1910 but that he only read

it about once a week and his usual report was that the river was stationary. These data were so poor that no attempt was made to work them up. In conclusion, the data have been secured in a very careless maner and they contain errors, I believe these data for
1912 are the same referred to by Prof. Carpenter in his testimony and the same used by Mr. Field in his testimony. Refer-
4304 ring to Mr. Field's estimate of 12,800 acre feet probable run-off from mountain territory out of Four Mile, Seven Mile, Cooper and other small streams, heading in the mountains north of the Little Laramie River on the west side of the valley, the only run-off from that area is a very small inflow at times from Mill Creek to the Little Laramie. The most of this water is diverted before reaching the river, and applied on lands in that vicinity along the creek. Except Four Mile, I should say no water enters the Laramie River from those streams other than perhaps a small volume from Four Mile after very heavy torrential rains. The meadows along Four Mile require what little natural flow
4305 there is in the foothills, so practically no water reaches the Laramie River from that Creek, as I have observed in crossing it. King's survey of the 40th parallel made in the 70's shows Cooper, Dutton, Four Mile and Seven Mile Creek as not extending to the Laramie River. Cooper, Dutton and Seven Mile enter depressions, but the other tributaries are not shown as continuous to the Laramie River, showing that at that date there was no inflow. Seven Mile flows into James Lake, to which there was no outlet prior to the construction of the James Lake Irrigation System. Cooper and Dutton Creeks flow into Cooper Lake, having no connection with the river. There is practically no inflow from the source whence Mr. Field estimates 12,800 acre feet.

4306 Referring further to his testimony estimating an inflow of 12,800 acre feet from the mountain area on the east side of the Laramie Plains lying south of a point opposite Two Rivers, and a point opposite the Wheatland Reservoir, being an area of about sixty miles in length by five miles in width, very little water is contributed to the river from this area and that flows in from shall tributaries south of Laramie such as Soldier, Willow and Five Mile Creeks, and then only in times immediately following heavy rainfall or perhaps a very small flow may reach the river during the melting of the snows in March. From that area lying North of Laramie, there is practically no inflow to the Laramie River from the area extending along the slopes of the Black Hills to the Wheatland Reservoir. On April 25th I made a special inspection trip of those channels or draws between the steel bridge at the Two-Bar shearing pens and Laramie and outside of a few small draws which may carry a little water after very heavy rains, and which enter the Laramie river a short distance above the steel bridge or immediately north of Laramie practically no water enters the Laramie River from the Black Hills. The slight flow or run-off from this area is intercepted by lakes and ponds and is also intercepted by the Oasis and Boughton Ditches, and in turn carried to the lakes and ponds.

The run-off in the Black Hills is very meagre, occurring only after torrential rains or the melting of snow in the early spring. In frequent trips to the Wheatland Reservoir during 1912, 1913 and 1914, I have never seen in the aggregate over a few second feet in any of the ordinarily dry channels crossing the road to McGill, and then only after heavy rains or in March or the first few days of April. Some of the water originating on the slopes of the
4307 Black Hills is absorbed in transit by the sedimentary formations at its base. Reference to the Laramie Quadrangle topographic map of the U. S. G. S. shows the intermittent nature of the drainage from the Black Hills of these channels and the termination of the flow near the base of the hills. Mr. Field's estimate of this inflow is much too great.

Referring to Mr. Field's testimony as to the estimated discharge of 18,300 feet in Chugwater, reported by the State Engineer of Wyoming for 1911 and 1912, the gauging station is located on the C. & S. railroad, about thirty miles above the mouth of the creek about the point where it leaves the foothills proper. There is some irrigated land both above and below, but mostly below on both sides. I do not know of any gauging station at the mouth of Chugwater, but at one time after three days' rain on the Wheatland area I saw perhaps 75 or 100 second feet running into the Laramie River from that stream. Otherwise never more than a few second feet. The flow of this creek is practically absorbed by irri-
4308 gated lands lying along the stream, the record referred to being the record at the gauging station at Chugwater.

Referring to Mr. Field's testimony in connection with Defendants' Exhibits 136-141, and especially the chart dealing with the diversion of water through the Pioneer Canal Enlargement to Lake Hattie and to the Pioneer Canal proper, Mr. Field has taken the amount of water diverted by the Pioneer Canal enlargement which includes the water diverted to Lake Hattie and the water which is used on lands under the old Pioneer Canal, and then, in addition, made an allowance for the Pioneer Canal, thus duplicating the volumes of water used by that canal, an error which is perpetuated throughout the table, amounting to 17,700 acre feet in 1912 and approximately 12,000 acre feet in 1913 in both charts. As to
4309 the storage capacity of the Wheatland Reservoir No. 2, based on a survey of the high water mark in October 1912, and levels taken at the outlet and using the contour map filed in the State Engineer's office for that reservoir, I determined the active capacity to be 83,400 acre feet.

The last two years' record of the inflow ond outflow without refined computations, indicate that the capacity is even less. On May 15th, 1914, according to the capacity of the reservoir, there were 58,000 acre feet of water impounded. On the same date in
4310 James Lake reservoir there were stored 21,400 acre feet, and in Lake Hattie reservoir, 26,500 acre feet storage active on all occasions. This would leave on May 15th, 1914, an unused storage capacity of 25,500 acre feet in Wheatland Reservoir No. 2; 15,600 acre feet in James Lake Reservoir; and 42,000 acre feet in

Lake Hattie Reservoir, a total of 83,100 acre feet of unoccupied active capacity.

Referring to the testimony of Messrs. Hedke and Duvall relating to the filing maps or blue prints of the several irrigation works finally merged in the Greeley-Poudre or Laramie-Poudre project, I have had typewritten copies of the statement prepared and bound, together with all the filings, which I produce. (Plaintiff's
4311 Exhibit U-1.)

Mr. Carpenter: Objection as not the best evidence or any evidence of what original filings show, and as immaterial and irrelevant in that all matters pertaining to said water rights are merged in the decree of the District Court of Larimer County, Colorado, Exhibit 179.

I have also blue prints of the maps obtained from the State Engineer's office and identified by Mr. Hedke in this case, which are on many different scales and of different sizes. I have
4312 prepared a map upon which these blue prints have been transferred and combined in a single map upon a uniform scale, which I produce (Plaintiff's Exhibit U-2), and which is a correct transcript of the drawings in the blue prints. Featured in three different colors are shown the outline in vermillion, indicating the location of the lines of the Link Lake Ditch and Reservoirs since referred to as the Upper Rawah Ditch, which was originally and early planned for the diversion of water from the headwaters of the Laramie River by the Sky Line Canal to the Poudre River for the irrigation of lands in the vicinity of Fort Collins. The black line bordered on each side with vermillion extending from the west fork of the Laramie River to Chambers Lake represents the constructed Sky Line Ditch, and the vermilion dotted and solid lines lying to the north and west of the west fork of the Laramie River represent the projected ditch shown by these filings, the continuous line indicating the portion that is practically constructed. The filing dates, viz: Filing Nos. 1722, October 6, 1904; 3049, February 24, 1906; 5448, January 8th, 1909" indicate the dates and filings in the State Engineer's office as shown by the dotted lines. The dotted and solid lines in green represent
4313 the various plans for collection ditches and tunnel, which are now merged into one scheme for the diversion of the headwaters of the Laramie River to the Poudre River. The brown dotted line indicates the reservoir and canal detour system around Boulder Ridge from the headwaters of the Laramie River to the Poudre River. The same filing is shown in the small key map at the lower lefthand corner of the sheet, on a smaller scale so as to include the entire project in one sheet. The waters of the Upper Rawah Project could be carried to and through the tunnel by discharge into the West Fork of the Laramie, and if these waters were turned into the West Fork instead of being carried across that stream into the Sky Line Ditch, they would go on down to the tunnel. These waters can be carried either way. The solid green lines

indicate constructed work and the dotted lines projected
4314 work according to the filing. The brown dotted lines indicate a distinct alternative route from the green solid or dotted lines, and the Upper Rawah system shown in vermilion being also a distinct system which can be made supplemental to the tunnel system and used either way. The solid colors indicating constructed work were made from personal examination in 1913.

Mr. Carpenter: Objection to introduction of Exhibit U-2 as not best or any evidence of true location of lines; for improper conclusions of witness noted on map and not supported by record; incomplete through omission of data appearing in original records, and to conclusions of witness on matters of intent of original appropriators as settled by court decree, Exhibit 179.

4315 I think I heard most of the testimony of the Colorado witnesses in regard to the surveying and construction work done from time to time on these various projects; also the testimony of witnesses for Wyoming as to the surveying and construction work done from time to time on the Lake Hattie and Laramie Water Company's work, and have since read the transcript of the testimony from which I have constructed a chart showing graphically the progress of surveying and construction work on the different projects which I produce (Plaintiff's Exhibit U-3).

Mr. Carpenter: Objection as not best evidence because of incorrect statements noted as facts, conclusion of witness, omission to note work shown by testimony to have been done, improper segregations of portion of Laramie River works from remainder, contrary to the evidence in this case and the decree of District Court, Exhibit 179.

This chart is scaled so as to show approximately the rate of construction as measured by the amount of expenditure from time to time as best could be deduced from the testimony, the captions and the legends showing the significance of the different colors. The work designated in red indicates the time when money was expended on construction and the relative proportion of the same on
4316 the Pioneer High Line system and the related parts. The yellow, the time and proportionate expenditures or construction of the Link Lake or Upper Rawah Ditch. The green (Plaintiff's Exhibit U-3) shows similar data on the Laramie River system of the Greeley-Poudre Irrigation District; the blue, the data on the Poudre Valley system, on which last mentioned system I was unable to secure from the testimony the entire amounts expended and the exact time, so that it is necessarily incomplete.

4317 From my records and experience, the duty of water diverted from the Laramie River between the Pioneer Dam and Two Rivers Stations is approximately one acre foot per acre. This includes copious flooding of the meadow lands and irrigation of the pasture land adjacent to the river. If all the lands irrigated between these stations were included, the duty of water would be higher. I am familiar with the method of diverting, carrying and applying

water in the Laramie Plains and also in Colorado. The irri-
4318 gation on the bench lands of the Laramie Plains is very similar to the irrigation generally in Colorado, notably on the Gunnison, the South Platte and the North Platte Rivers, and the Arkansas, and other streams where native hay is raised in large quantities. I am familiar with the character of the diversion dams, head-gates and other similar irrigation works in the Poudre Valley in Colorado, and those on the Laramie Plains, with the exception of some very small dams. The works on the Laramie Plains compare very favorably with those in the Poudre Valley in efficiency and with respect to the waste of water, and those ditches which have temporary dams usually only require those for the late meadow
irrigation or otherwise the dams would be more permanent
4319 in character. The temporary character of the dams does not result in a waste of water because there are large numbers of ditches below that have prior requirements to which water must be passed. Taking into consideration the entire system of ditches and reservoirs on the Laramie Plains and especially the location and character of the Wheatland Reservoir No. 2, the net loss or waste of water resulting is no greater than in other irrigated areas generally and for the reason that the Wheatland Reservoir No. 2, which is a channel reservoir and has a large priority over many of the ditches above receives all the return flow of the river and its tributaries above that point and uses it, making it available for use on the Wheatland lands below, there being no corresponding condition in Poudre Valley, where water is more likely to be lost than in the Laramie Valley. The return flow from the irrigated lands along the Laramie River is very rapid.

Referring to Mr. Field's testimony about the number of natural channels of the Little Laramie River into which the flow of the stream is divided, this does not indicate an unnecessary or unusual waste of water, as it would be necessary to construct an extensive system of ditches and laterals at greater cost if these natural channels did not exist, and the artificial ditches would give a greater waste
and loss.

4322 (On resuming his testimony.) Referring to Exhibit T-7, I desire to ask for the following corrections:

Change opposite "Lake Hattie Reservoir" 69,855 to 52,152; change opposite "Two Rivers" 89,550 to 107,253. In the table I duplicated the 17,703 acre feet used by the Pioneer Canal including it the second time in the Lake Hattie Reservoir diversion. This error misled Mr. Field in his Exhibit No. 136, the error in which is based on the error in Plaintiff's Exhibit T-7 which is the table replacing Plaintiff's Exhibits B and I. The error referred to does not occur in Exhibit 141.

At page 220, Volume 1 of the Plaintiff's evidence, the dates of
measurement and record of the flow of the Laramie River
4323 should be 1912 and 1913.

On page 226 the reference to the flow of the Wheatland Reservoir No. 2 from May 1st to August 17th, 1913, should read

"Covering the period of May 1st to August 17th, 33,870 acre feet" in place of 90,053 acre feet as shown in the transcript.

In the third answer, same page, the inflow into the reservoir from January 1st to August 18th, 1913, is 63,463 acre feet.

The correction of the errors as to the flow and distribution of water in the Laramie River in 1912 does not affect the flow, but simply shows a redistribution of the water.

4323 Cross-examination by Mr. Fred Farrar:

Effect of change which I have just made in table shown on my Exhibit T-7, wherein I have changed inflow into Lake Hattie Reservoir for year 1912 from 69,853 to 52,152, decreases volume of water charged to Lake Hattie Reservoir by 17,703 acre feet and credits same volume to Wheatland Reservoir No. 2 and intermediate
4324 ditches below Two Rivers. When I say "credits" I mean that that much addition- water above my original figures was taken into Wheatland Reservoir No. 2 or intermediate ditches.

The same error occurs in Table, Plaintiff's Exhibit "B" which was introduced in evidence August 22, 1913.

I was in error at outset of taking of testimony in this case.

Later on I revised this table shown on Exhibit "B" and superseded it by table shown on Exhibit "I," which was introduced some time later in case.

I made same error in my revised table shown by Exhibit "I."

I again continued the error in my table Exhibit T-7, which was introduced yesterday.

My mistake was not discovered by myself until my criticism of Mr. Field's diagram shown on Defendant's Exhibit 136 and it was challenged by him.

In my direct testimony, I have assumed to term as unreliable in some cases and questionable in other cases, records of stream flow or discharges made by other engineers and other hydro-
4325 graphers. I am willing to admit that even I am not infallible.

I have delineated factors to which I attributed inaccuracy in measurements of flow of water in streams. These same factors were pointed out by witnesses for defendants, more particularly Professor Carpenter and Mr. Field. These inaccuracies which I mentioned may occur wherever stream measurements are made.

They are not matters of criticism directed specifically toward earlier records of Laramie River but include other measurements.

If same errors are apt to occur in any set of measurements, same things may be said of other measurements taken at other places and by other persons.

In all measurements there is certain human factor that may contribute either to accuracy or inaccuracy.

Assuming some of these factors may have been present in measurements taken, for illustration at Boswell Station on Laramie River, it is reasonable to suppose that same errors may have occurred in measurements which were taken above Boswell Station on that stream and also *that* those which may have been taken at other places on

Laramie River and on its tributaries, but those are determined by analysis of specific data of any station.

If same errors prevail at different places on stream these errors would in a measure be compensating, but it must be remembered that at upper stations on Laramie River there is less volume of water and less opportunity for gross errors. Velocity of
4326 water at Glendevey Station, one of upper stations, at high water, is probably greater than it is at the interstate line station, there being greater grade in river at upper station.

Experience is not only requisite necessary to proper accomplishment of measurement by current meter, that must be supplemented by care and judgment in work. There is certain judgment required which is supplied by experience. It is the outgrowth of ex-
4327 perience. It is not a question of adaptability. It is my experience in engineering work and especially in the measurement of water, that many men take up this field of work who demonstrate by the quality of work and methods they use that they are not adapted to it primarily from viewpoint of accuracy and care. This is true of men in all professions.

My conclusions as to stream flow are based almost entirely on my measurements made during period commencing April 12, 1912, supplemented by analysis of older data. I did not use my figures as basis for critical analysis. I used hydrographic methods with which I am familiar and have acquired through good many years' experience in rating older data.

I made part of this analysis since evidence on behalf of defendants has been given. Large part of it was made prior to that time. Everything I have done relative to analysis of basic data governing other records has not been with idea of sustaining my original statement shown on Exhibit "B" and Exhibit "I," introduced during testimony of examination in chief by me, wherein I committed myself to runoff for 1912 at Woods Landing of 207,000 acre feet. I have made my analysis and determination since that time with view of arriving at actual volume of water that is available.

My original statement of 207,000 acre feet as made in my Exhibit "B" was based entirely upon my own measurements where I had them, supplying them by estimates for few months for year 1912 from data secured under known conditions. After critical examination of all other records taken by other observers I have not modified my estimate made for year 1912, because those data were secured under known conditions and worked up carefully and rigidly.

I have not in any way materially modified any other conclusion at which I arrived relative to total or mean annual flow of Laramie River. My decision or conclusion as to annual flow at vicinity of Woods Landing Station or Pioneer Dam, I have had to refer to in a way and to use old records, because I would be unable to determine runoff of Laramie River in average year from one year's measurements. My analysis and digest of these late data leads me
4329 to believe it is less than their face value shows. I do not desire to be understood as testifying in the case in chief only to flow for years 1912 and 1913. I believe I testified yesterday that

mean annual runoff of Laramie River in vicinity of Woods Landing station was approximately 200,000 acre feet. I did not arrive at that conclusion some months ago. I do not arrive at conclusion that these old records are all excessive I cited one specific instance where re-working of those had increased flow greatly.

I think there are quite a number of gross instances. If old records are taken at their face value annual flow of Laramie River at Woods Landing is grossly in error. It is excessive.

These records which I have revised, have not discarded entirely, include records made by state engineers of Wyoming, United States Geological Survey, state engineer of Colorado and by Professor L. G. Carpenter and others. In my particular case it was a revision downward, because everything contributed to that point. There is no uncertainty as to gross error in winter flow of Laramie River at Woods Landing as secured by State Engineer of Wyoming and by United State Geological Survey in early years and this matter can easily be affirmed by careful investigation by any hydrographer of experience.

4330 If gauge rod were raised in any manner it would not show true volume of water and would give values less than the actual. Ice in stream may have tendency to raise gauge rod, but I do not recall more than one or two instances where rods were actually raised above their true position by such causes. Invariably the error is settlement. Effect of ice forming around gauge rod and object to which it is attached would depend upon stability of piers or abutments to which attached. If pier or abutment to which it is attached was not solid and substantial usual tendency would of course, be to raise it. The true winter flow is very small in comparison with spring and summer flow, on Laramie River, but acceptance of old winter records such as those at Woods Landing, which are greatly in error and show in some of low water months January and February, as high as 50,000 acre feet, when actually a runoff of in the neighborhood of 5,000 or 10,000 acre feet, could not be accepted.

4331 I heard Mr. Field's testimony that he had discarded winter records of which I speak in arriving at his determination. There were 2 or 3 years in which the errors occurred. There was one specific error that was obvious.

Exhibit T-2 is based upon my discharge curve Exhibit T-1. The Sixth vertical column on Exhibit T-2, reading from left, indicates flow of water at respective gauge heights through culverts at different stages. This particular column is located at upper left hand corner of Exhibit T-1 and is designated as curve for culverts west of road.

4332 According to table Exhibit T-2 discharge through these culverts west of road at gauge height of 3.65 feet is 480 cubic feet per second. Curve shown on Exhibit T-1 shows discharge at that particular gauge height of 580 cubic feet per second.

I am evidently again in error in one of these tables. 580 is correct.

I desire to have a correction noted on my table Exhibit T-2.

Change in table as shown in next column to right should be corrected to 2,300 and an increase of 100 second feet.

At a gauge height of 3.6 feet the total flow through channel and culverts would be 2,080 second feet.

I recall that Professor Carpenter found that on June 4, 1912, at gauge height of 3.62 feet, there was a total discharge of 2,512 cubic feet of water per second of time.

I find that at the gauge height of 3.4 feet there was passing through culverts and outside channel 100 cubic feet of water per second of time. In absence of other data I used Professor Carpenter's discharge measurements as basic data.

I departed from his discharge measurement at higher
4333 gauge heights for culverts only.

According to my table I find 10 cubic feet of water going through culvert outside of channel at gauge height of 3.25 feet.

Figures shown in this column six are based on discharge measurements of culverts by Professor L. G. Carpenter. Overflow according to my determination, occurs just above 3.2 on gauge.

On April 2, 1914, I directed an inquiry to Robert Follansbee, District Engineer for United States Geological Survey at Denver, relative to certain measurements made by Geological Survey at this station. The answer is as follows:

4334 "300-304 CHAMBER OF COMMERCE BLDG.,
DENVER, COLORADO, April 3, 1914.

Mr. R. I. Meeker, c/o Laramie Water Company, Laramie, Wyoming.

DEAR SIR: I have your letter of April 2d relative to the highwater measurements made by Mr. Fletcher on the Laramie River at Boswell's Ranch in 1911.

The original notes for these measurements are in the Washington office, and therefore, I am unable to give you definite information in regard to them at this time. In discussing the matter with Mr. Fletcher, however, he states that, to the best of his belief, he used one 15 pound and one 6 pound torpedo weight on the meter which was suspended by a single wire, reducing the obstruction to the current to a minimum. In the swiftest part of the current a stay line was used in addition, which insured accuracy of soundings and accuracy in holding the center of the meter at the .2 and .8 depth for determining the velocity. He is not certain in regard to correction for angle, but believes that this was not serious in any event. While he did not actually see the overflow channels, he instructed his assistant to examine them to determine whether there way any flow. As the latter reported that there was no flow, Mr. Fletcher did not visit them for the purpose of making measurements.

As the accuracy of these measurements was questioned last summer, I made a special trip to the gauging station September 1st and 2nd, and ran lines of levels myself to determine the approximate gauge reading at which the overflow would begin. In addition to running a line of levels across the valley to determine the cross

section of the several small overflow channels, I ran levels up the river as far as the beginning of the main overflow channel to determine the fall between the two points. From these levels I have compiled the following notes:

The main overflow begins approximately 1,050 feet upstream from the gauge (located at the bridge). Between this point and the gauge there was a fall of 2.5 feet at a gauge reading of 1 foot. The lowest point in the main overflow channel at the river bank was 1.4 feet higher than the water surface. But while the river would overflow this point at a rise of 1.4 feet (or a reading of 2.4 feet on the gauge), it could not flow through the main overflow channel until it rose .6 feet higher (or a gauge height of 3 feet), as the overflow channel rises that amount within a short distance of the river bank. Therefore, on the assumption that the slope of the river does change materially between the two points within a range of stage of a few feet, it is not possible for water to flow through this main channel until the gauge reads 3 feet or higher. Although there are two or three much smaller overflow channels which might possibly carry water at a somewhat lower stake than 3 feet, the culvert openings under the road are so small, that until water passes down the main overflow channel, the total amount of overflow would be very small.

I am writing the Washington office to send me the original meter notes in order that your question may be answered more fully.

Very truly yours,

(Signed) ROBERT FOLLANSBEE,
District Engineer.

4335 (In accordance with Survey regulations, I am enclosing a copy of this letter to the State Engineer of Colorado.)"

4336 (Witness continuing:) I have not allowed any overflow whatever at gauge height of less than 3.25, notwithstanding that Mr. Follansbee states that two or three of the small overflow channels might carry water at gauge height of less than 3 feet, but I have used Professor Carpenter's data which is more direct in fact than others in showing actual water conditions at that stage. I do not know that Professor Carpenter was more conservative than the United States Geological Survey, on point of overflow, from Colorado standpoint. Measurements of Geological Survey are based on levels when no water was running and do not show actual conditions when water was running, although they show topography and in a way confirm Professor Carpenter.

Standard area curve of which I have spoken in my tables and my area curve, I obtained by taking the same with a level and rod and then checked sounding at low water stages and used a few of soundings at low water stages in making determination. The standard cross section is the actual area curve at that point. I made those measurements April 11, 1914. Professor Carpenter's measurements were made in May and June, 1912.

Upon measurements made two years subsequently, I have

assumed to criticise cross section area used by Professor
4337 Carpenter in determining his discharges. I have affirmed that standard by conditions that existed there early in 1913, showing that cross section is practically permanent. I am practically sure that conditions obtained in 1914, when I made my measurements, are same as actual cross section area existing at time when Professor Carpenter made his measurements two years earlier because measurements in middle of stages, at middle and low stages in 1911, '12 and '13, all check.

Effect of presence of debris and silt which river might carry during high water, upon overflow channels after water began to subside, would be to decrease amount of water passing through culverts. A considerable amount of debris might and probably would be left in channels as water subsided.

I did not make any measurements of overflow channels. I accepted Professor Carpenter's.

If there was any silt in cross section of main channel at low water stages, it would be scoured out during high water, but examination of cross section late in fall of 1913 and again in spring of 1914 and also early in 1913, when I made measurements and visited station do not indicate deposition of any silt at that station.
4338 Rock bottom is exposed at all stages.

Relation between volume of water and velocity of flow is to show increase with stage. The higher the water the greater the velocity under open channel conditions.

Examination of river channel at Colorado-Wyoming line station for several hundred feet below and down to the ripple, the controlling point for that station, shows that no condition of sedimentary deposit affects the flow at that point. That was on April 25, 1914 and also in 1913, I waded down there and examined it when I made measurements. In fact I made measurements even low- and I have been up and down channel, and it is clean cobblestone and boulder bottom.

At point where cross section measurement was made, bed consists of some jagged fragments of rock, some cobblestones, a few boulders in main channel and in auxiliary channel there is a little sediment. Main channel is comparatively smooth and regular at that point. There are some holes among these cobblestones and boulders which give occasion for securing too high soundings. I would say that moderate conditions for mountain stream exist at that station. I recall that in taking soundings there, if I didn't use care, I could secure soundings in holes which would give depths of 6 to 8 tenths of a foot deeper than what the true bottom surface would
4339 be. This did not involve an exercise of judgment, by making numerous surroundings and feeling around to determine average bottom surface, measurement was obtained. No particular judgment and experience was necessary except judgment and experience in measuring stream to avoid securing too great a cross section area. My conclusions as to mean annual or normal flow of Laramie River did not involve use of records of North Platte. Records of that stream were introduced to offset some conclusions by State

Engineer Field, who used percentages for Poudre River and applied them to Laramie River. I stated there was great similarity between North Platte River above Saratoga Station at which records were taken and Laramie River above Woods Landing. Saratoga station is approximately 40 miles north of Colorado-Wyoming line. There is irrigation by water diverted from North Platte River between Colorado line and Saratoga. There is copious irrigation of meadow land from North Platte River above Colorado line in Colorado.

4340 North Park may, from topographical viewpoint, be compared with Laramie Plains, in that it is a wide mountain plateau surrounded by hills.

North Platte River and tributaries head in mountains to east, south and west of North Park. North Park is a little over 30 miles east and west from rim to rim of boundary mountain ranges. Tributaries of North Platte River which head to south and west of North Park flow from Park Range on west and Continental Divide on south of Park. Park Range to west is portion of Continental Divide. North Park is about 30 miles from north to south and has an area somewhat less than Laramie Plains. In arriving at comparison between Laramie River and North Platte River, it would not be proper to compare North Platte River at Saratoga as to percentage of flow in any one year to normal with records obtained at Laramie River at Lookout, that would be too far down drainage basin in my opinion. That is practically below all irrigation outside of Wheatland Project.

Nevertheless very similar topographic conditions exist above these two stations, that is, above the Saratoga Station on the North Platte River and the Lookout Station on the Laramie River. It

4341 was necessary to use existing records. There are no records above Saratoga except right at Park.

I have stated that Mr. Field took high records at arriving at his conclusions. Where conflicts or uncertainties existed, that would of necessity mean that he took high records for all discharges of river and its tributaries in Colorado as well as in Wyoming. I would say that that would work against Wyoming. The taking of high records would indicate more water than actually existed at Glendevey and demand or drawing of Greeley-Poudre System would more greatly deplete actual runoff than it would the overestimated runoff, giving Wyoming less water.

At Pioneer Dam staff gauge and automatic are maintained. Automatic registers two feet higher than staff gauge for reason that automatic is operated the year around and in order to keep pressure bulb free from ice conditions it is placed two feet below crest and at high water stages, if range of chart is insufficient, pressure of bulb is then raised a foot or two feet during those times, in order

4342 to get full range of chart and get record of all water passing over dam.

There is no data, it is simply marked on chart by crossing out printed figures and ma-king in a red zero 2 feet above zero shown on chart. Since installation of that Bristol Register, there has been no change in pressure bulb. It has remained constantly two feet below

crest, but on account of higher water stages, it will probably be necessary to arrange it this summer during high water. In operating a Bristol Register it is necessary to keep pressure bulb two feet below highest surface.

At Lockout Station, where I have reversed condition and staff is approximately one foot below automatic, I had also adapted chart to meet range of river and changed printed figures to indicate datum of pressure bulb. Automatic is above staff because it is not possible to put pressure bulb, without considerable expenditure and digging well and conduit, to very bottom of river. Chain gauge is set. Datum is established so there will never be any negative readings. In other words pressure bulb is placed in lowest portion of channel adjacent to right bank and below all low water. Chain gauge registers a foot greater in depth each time.

4343 All readings at Lookout Station are based on chain gauge. Changing of datum point on chart simply being tabulated to secure flow at proper range.

Chain gauge is read every time chart is changed and a notation made on chart, so that if pen is in error, there can be proper correction, but there have been very few corrections on any of my Bristol Registers, because I have operated them personally and pens are in excellent shape.

Chain gauge which I have at that point does not maintain constant register. It only registers elevation of water surface when it is lowered. Upon each occasion when I visited it once a week I lowered my gauge into river and took my reading. Chain gauge is basic gauge for keeping Bristol Register adjusted just the same as staff gauge is. In operation of any sort of automatic water register, Bristol or flood type, it is necessary to have staff or chain gauge, which is permanent and data found on that are used for setting pen on charts.

4344 Staff gauge was installed by Wyoming Development Company at Lookout Bridge in April, 1914. This staff gauge is set, as I checked by reading to compare it with reading on chain gauge at same time at same datum.

I do not have the gauges at these two stations, Pioneer Dam and Lookout, so adjusted that a person who did not understand adjustment would not be able to determine which is correct. Datum is indicated on charts, so that it is a mere matter of referring to chain gauge to compare with chart. Datum is noted sometimes after and sometimes before chart is taken off. Notations are made on chart of chain gauge readings so there is no doubt as to what pen is reading and there can be no confusion in matter.

April 11, 1914, when I made my measurements at Boswell Station, I did not make measurement of river.

Am unable to give exact figure of amount of water passing Laramie at this time (May 23, 1914) because I have no staff here. There is an old gauge here that was established by Professor Greenway or someone. It was there in 1913. I could just give a rough figure in this way, by stating that yesterday there was approximately 1400 cubic feet per second passing over Pioneer Dam.

There is no water being taken into Lake Hattie inlet. The
4345 reason for not taking any water could best be answered by Mr. Schrontz, General Manager of Laramie Water Company. I know the reason. Think Mr. Schrontz's plans have changed some in last 2 or 3 weeks. He has planned to finish some drainage work at lower toe of dam that was unfinished in 1913, and to make an inspection of concrete facing at point where it is broken on inner toe at and on water surface this summer, and for that reason he does not wish to run any water at this time into Lake Hattie Reservoir, there being sufficient water for this year's needs of North Canal.

There are 26,500 acre feet of water now in Lake Hattie, as I yesterday testified. That is sufficient for this year's needs under North Canal.

Water is storing at this time in Wheatland No. 2 Reservoir. On May 14 I visited that station and entire flow of river was being stored. I did not see Mr. Elliott when he was here day before yesterday. I am not aware of fact that storage has been discontinued in the reservoir for this year. I based my statement on my visit on May 14th, when no water was discharging from reservoir.

4346 Comparing flow of Laramie River at this time this year with the same time last year: May 22, 1913, flow of river at Pioneer Dam including water diverted by canal enlargement, that is the flow just above dam, was 500 cubic feet per second in round numbers. On May 22, 1914, it was approximately 1400 cubic feet per second.

Flood waters did not commence earlier this year than last. They have culminated later. On May 1, 1913, flow at Pioneer Dam including flow of Pioneer enlargement was 500 cubic feet per second. On May 1, 1914, flow was 221 cubic feet per second. That indicates that high water commenced earlier in 1913. It might be said to have commenced the last two days of April.

In my judgment highest flow of Laramie River for 1914 has not yet occurred.

While, as matter of fact, we have almost three times amount of water, according to my measurements at Pioneer Dam, on May 22 of this year, as compared with the measurements for same time last year, it is my judgment that the river has not yet reached its highest point for this year. True comparison between runoff for this time of year cannot be made between days but must cover period of ten or twenty days or a month.

Comparison- of relative amounts of water which have passed down river this year in month of May as compared with last year (1913) are: Taking gross flows from May 1 to May 15 of both years, during period of 1914, runoff of Laramie River at Pioneer dam
4347 was approximately 4000 or 5000 acre feet more than it was in 1913. This occurred notwithstanding fact that high water in 1914, commenced later than it did in 1913.

We have this condition, that Lake Hattie has at this date all necessary storage for this year and vast quantities of available water are passing the dam. Water is passing dam and will be used by Wyoming Development Company at this time since there remains

considerable storage capacity in Wheatland No. 2 Reservoir. Water is not being wasted.

We have in prospect highest water yet to come for year 1914.

Assuming, for sake of question, that Wheatland Reservoir has sufficient water, water must pass down the Laramie River during 1914 into the North Platte River.

Since I gave relative flows for year- 1913 and 1914, from May 1 to May 15, I have discovered an error. Flow in 1914 was 13,400 acre feet and in 1913 was 1,600 acre feet for same period.

I still however desire to maintain statement I made that on May 22, 1913 there was approximately 500 cubic feet per second flowing in river at Pioneer Dam and in 1914 approximately 1400 cubic feet per second. Based on snow reports and all information
4348 I can secure in reference to water conditions on stream, it is my judgment that 1914 runoff will be very close to 1912. It will be probably 200,000 acre feet. I predict a much heavier flow in 1914 than there was in 1913. That is not mere speculation, it is from my present knowledge, and is a positive fact. We know from condition of snowfall that runoff will be larger than it was in 1913.

Practically no water reaches river from drainage area from mountains east of Laramie Plains, at least as to that portion lying north of Laramie. It is intercepted by ditches or ponds and lakes between river at base of mountains. There would be slight runoff after heavy rains from area to east. Do not know whether the heavy rain that occurred in Laramie an hour or so before I testified on that point caused any runoff to reach the stream. I believe the runoff of the streets of Laramie reaches the river through sewers but the sewer capacity is not very large. On the open country, topography
4349 is such that large portion of it would be collected in ponds, in depressions and draws. From there it evaporates and seeps away. A greater portion of water would be absorbed in transit in passing down drainage channels. I also stated that considerable portion of water which flows from hills is absorbed in formation at base of hills. It passes into underground strata. Based on what information I have from geological standpoint, it would not reach the river. Strata is permeating and porous. We have unpermeating strata on the other side. This formation is peculiar to the base of the foothills where the edges of the various strata outcrop and can't intercept water. Further out on plains strata are more nearly horizontal and also shale occurs which would intercept water from sinking
4350 deep into strata beneath.

Oasis and Boughton Ditches might take up very small volume of water from hills to the east. In the past two years that I have been in this vicinity have made trips to McGill and at one time there was continuous rain for three days and it was on third day that I made trip, there was practically no concentration of that runoff in drainage channels across road to McGill. In making trips from Laramie City to Wheatland Reservair I have had occasion to observe a num-er of channels which indicate that water passes into river. I have been in torrential rains of short duration down there many a time.

There is irrigation from Soldier Creek, Willow Creek and Five Mile Creek. Water for this irrigation is taken from these creeks. I know personally that there is irrigation on Seven and Four Mile Creeks but I have not examined Dutton or Cooper Creeks.

4352 LARAMIE, Wyoming, May 23, 1914.

R. I. MEEKER.

Cross-examination continued by Mr. Fred Farrar:

Gauging station at Chugwater Creek is approximately 30 miles above mouth of that stream, that is, about its confluence with Laramie River. There is irrigation along Chugwater Creek both above and below the station, by which water is diverted from creek. Creek joins Laramie River near town of Wheatland. It flows along eastern boundary of Wheatland District.

I understand there is reservoir that was built by Swan Land and Cattle Company in vicinity of Chugwater, which went out and they have plans for use of considerable volume of water there. I believe gauging station at Chugwater was established by U. S. Geological Survey to secure data at their request. At times I have
4353 been in there and talked with them, they have spoken of an irrigation system that was projected by company. There may have been proposed channel reservoir in vicinity of Iron Mountain, don't know exact location. Observed possibility of reservoir in traveling through country where creek breaks through range. Any such reservoir would be dependent on water in Chugwater Creek and tributaries for supply.

I recall no reservoir on Poudre River, channel reservoir, at lower end of irrigated area which would intercept water which passed from dams above, similar to Wheatland No. 2 Reservoir. I know of no possible reservoir of that nature which would be constructed on Poudre River.

As matter of fact topographical condition of Poudre River is such that no such reservoir as Wheatland No. 2 Reservoir could be constructed.

I am aware of fact that there are certain demands on Poudre River from appropriations made from South Platte River below junction of Poudre with Platte.

Dead or unavailable capacity of Wheatland Reservoir No.
4354 2 is roughly about 35,000 acre feet. A channel between the two basins constituting the bottom of this reservoir might make a small volume of water available from the north basin. Controlling feature of active and dead capacity is present outlet of reservoir. Do not think it practicable to modify present outlet on account of low grade of river at that point.

Am familiar with map of Wheatland Reservoir No. 2 filed in office of State Engineer of Wyoming November 28, 1901, showing area of 6,690 acres and a capacity of 120,420 acre feet in the completed reservoir. I know that such a filing was made. It was made

by Clarence T. Johnson, former State Engineer of Wyoming. Map shows contour lines at every five feet in depth.

Was not informed why records taken at Wright's Ranch in 1913 on Little Laramie River were not used by Mr. Field. I knew he had not used the records in his tables. Did not know reason.

4355 Referring to Exhibit U-2, in main body of map outlined in brown, I indicate reservoir site called Laramie River Reservoir Filing- Nos. 4912 to 5448, and in small key map in lower lefthand corner of map I show this reservoir on smaller scale and also ditch leading around Boulder Ridge from it. It is a detour canal, an alternative route. It was surveyed by Mr. Hedke. I recall that he testified that Colorado people decided not to use that route. The ditch is over 100 miles long. I believe the statement was made that water could not be gotten through the canal, after Mr. George G. Anderson had reported on it. Do not remember whether Anderson report corroborated Mr. Hedke. I can, however, identify this line of ditch and reservoir site with one that Mr. Hedke described as having been surveyed preliminarily by him. I know Laramie Water Company made a reservoir filing on this same reservoir site. That is the site which they describe as Glendevey

4356 Reservoir of Laramie Water Company's system. It is one of proposed reservoirs, another one being the one at the interstate line which is called the Roberts and McConnell Reservoir. This latter reservoir is also proposed by Laramie Water Company.

Laramie Water Company did not contemplate use of ditch shown by line on map U-2. Their plan is to utilize channel of river to convey water down to Laramie Plains and to use water within its own basin.

Cross-examination by Mr. Delph E. Carpenter:

On Exhibit U-2 I make various notations of dates of filing on various lines of ditches and tunnels indicated. Those dates refer to dates of filing in State Engineer's office.

In referring to the two lines indicated, as attempting to show location of Upper Rawah Ditch or Rawah Ditch of Greeley-Poudre System, I show two distinct lines. The more westerly of these two lines is that of the 1902 survey known as the Link Lakes Ditch.

I am aware of fact that that was a preliminary survey. I

4357 was not aware of fact that section corners had not been all of them ascertained at that time.

Heard the greater part of Mr. Zac. T. Duvall's testimony with reference to survey made on this and other ditches in 1904. Now recall that he stated that he was compelled to trace correction line from township corner to find corners along line of Upper Rawah Ditch and also re-trace township lines along Deadman and Nunn Creeks location to find corners. As I understand it, Lower and subsequent line of Upper Rawah Ditch was modified on account of material encountered and also on account of better line found thereby and not primarily from any section corner uncertainties.

I am aware of fact that along lower portion of line and what is known as Grassy Pass to end of ditch, location is practically the same. Also that detour as shown as appearing on section 34 in part was caused by Mr. Duvall deciding to go around Grassy Pass mountain instead of through a 35 foot cut.

The solid color- noted on certain portion of these ditches
4358 on this map refer to portions practically completed. There are flumes that have not been installed, waste ways and headgates, and so forth and perhaps a few short sections of prism that might be unfinished.

Beyond this portion marked "Completed" and clear up to this lake marked "Camp Lake" right of way has all been cleared through very heavy timber. I found small pits or openings where construction had been opened up. Did not indicate partial work on map because could not do it on the scale of the map with distinctness. Amount of construction would appear so small that it would not be practicable. Did not note fact that the way was cleared through very heavy timber. Have not indicated clearing on any of them. Clearing of timber was in that case a necessary and expensive portion of the construction. It cost, as I understand, about $1,000 per mile.

On this same Exhibit U-2 I indicate by solid green line marked "Constructed Lar.-Poudre Tunnel" as of filing No. 1722, October 6, 1904.

On another dotted line, being second dotted line from this solid to north, I put additional line of "Right of way map U. S. L. O., filing No. 3049." That refers to filing map in U. S. Land office at Denver, Colorado, for right of way application. Did not
4359 indicate right of way filing in United States Land Office on map along solid green line because was unable to find any such. Could find no government right of way for that line. It has been my experience that it is a customary procedure to secure rights of way as nearly as possible immediately prior to construction, but I have known cases where rights of way were applied for after construction commenced.

If right of way for this tunnel line was secured April 9, 1907, by government filing, I did not happen to observe it on government records.

Two ditch lines indicated on map in green, portion in solid color and portion in dotted line, known as two lower collection ditches of the Greeley-Poudre System, I only noted those portions in solid color which were practically completed. Rights of way for
4360 these ditches were cleared throughout. Very little excavation work had been done in any of dotted portion. There may have been very short sections which could not be shown properly on map of this scale. There are large portions of the ditch line commonly known as Deadman and Nunn Creek Ditch in vicinity of Brinker Creek crossing which is actually completed. This map is not intended to be absolutely complete in the portion of completed ditch. It is intended to give approximate status of construction. It is difficult to show every little piece of prism which has been ex-

cavated. Some of these portions are uncompleted prism. It is apparent to observer that on these two ditch lines, work was begun at various points along line and apparently by separate workmen or contractors. Subcontractors had been let various sections.

For all practical purposes, construction of the three lines of collection ditch, that is, Deadman and Nunn Creek Ditch, Rawah and Lower Supply Ditch, and Rawah Ditch, sometimes known as Upper Rawah Ditch, practically accomplish same object as would have been accomplished by construction of ditch noted on my key map as taking water from Glendevey Reservoir, around Boulder Ridge into Cache la Poudre River.

I have heard the testimony relative to several tunnel lines that were run by Engineers Tenney, Duvall and Hedke.

4361 In indicating line of Sky Line Ditch of Water Supply and Storage Company, as a completed canal, I did not intend to infer that this work had any of it been done by the Greeley-Poudre System or their predecessors in title. That, as I have noted on map is the separate and individual property of the Water Supply and Storage Company. It is shown in a distinct manner by double lines. I should not have noted at the same time by double lines, for same purpose, two ditches taking water from Laramie Lake and Lost Lake from viewpoint I was working.

Referring to Exhibit U-3, lead pencil lines denote beginning and end of years, small brown lines on map indicate monthly spaces. The larger brown lines are to be disregarded.

On this graph I have attempted to segregate the Greeley-Poudre System into three portions. The first two portions, going to make up that part of Greeley-Poudre System or work connected with the tunnel. The one in brown known as the Link Lake or Upper Rawah Ditch, being a trans-mountain canal, whereas Laramie River system, is indicated in green as collection system of canals and trans-mountain tunnel.

4362 The green merely includes the two or lower collection ditches.

That portion on Cache la Poudre River I have indicated by the line Poudre Valley System. That is wholly incomplete. I am unable to secure sufficient data from testimony to plat values properly and also periods of time.

Taking all three portions of graph referring to Greeley-Poudre System prior to 1909, I would not say that graph would show anywhere near expenditure of $800,000 to $1,000,000 on all three together.

If such were case my graph would be wholly incompetent to convey to the eye an impression of expenditure of money prior to 1909. It would be in error in that way. As you know graph is intended to show construction expenditures and as I recall I have not attempted to show any expenditures for *for* acquirements of rights, etc. No acquirement of already constructed ditches or anything of that kind.

Taking Upper Rawah Ditch unit of Greeley-Poudre System I do not show any expenditure of money in construction or toward that

end in 1905, 1906, 1908 or 1909. I do not recall any such testimony. Where I found expenditures had been made for surveying which were made for construction I incorporated those with construction.

4363 It is not intended to be shown by this graph that construction did not go on on some portion of the system, either on the Poudre Valley or on the Laramie River during any or all of the years just indicated.

Referring to year 1906 and that portion of graph representing Upper Rawah Ditch, I understand there were repairs made during some of those years but I made no attempt to include those. There was possibly a small amount of work done during year 1905. I do not wish to convey to the eye by this graph, the idea that no men were engaged in any kind of work on those ditches in those years. I could not do that.

In 1908 I indicate by graph that no work was done on Upper Rawah Ditch. If, as matter of fact, there were 282,000 feet of timber paid for on right of way of that ditch to Government of United States by owners in 1908, that would constitute an expenditure of money. Am also aware of fact that testimony of Mr. Akin shows that during years 1908 and 1909, more or less repair work was done by men upon this ditch, as I indicated previously I did not

4364 attempt to include repair work on the Upper Rawah Ditch. As matter of fact these several years which appear blank, are not intended to convey to the mind that there was absolutely no activity during those years.

Referring to section of graph marked "Laramie River System" which I intended to include tunnel and lower collection ditches, I indicate some surveying and construction in 1904. I fail to indicate any surveying or construction in 1905, 1906 and 1907. I do not recall the testimony of Mr. Duvall as to surveying done in 1905 in connection with tunnel.

(Testimony of Mr. Duvall appearing at page 1898 of Defendants' testimony relative to tunnel survey in 1905, read to witness.)

I remember that he made another tunnel survey but I failed to recall the year.

It is a fact that in all engineering undertakings, especially of the magnitude of this one, several lines are frequently run to determine which is the final and best line and all of the work has the same common end after all.

I understand that repairs were made on the Upper Rawah Ditch in 1913 by Mr. Wortham and party, but as I indicated heretofore, I have not attempted to show repair work on the graph. I have attempted to show primary construction work only.

I do not think it proper to defendants in this case to have omitted any notation of work done on the Cache la Poudre portion of Greeley-Poudre Irrigation District system of work owing to fact that I have so little data at my command relative to that portion of the system. Think it proper to show there was a Poudre Valley System and indicate what little information I had and put on the notation "In-

complete" and furthermore the testimony has brought out that feature. In attempting to illustrate on a graph, matters of that kind, such illustrations should be as complete as possible and I have made these as complete as I could with the information at hand.

Have already stated that the graph does not show upwards of $800,000 of expenditure on the entire system prior to 1909. All I have shown or attempted to show on this graph, and considerably more, will be found throughout the testimony in this case.

A few days since I testified concerning the Poudre Valley Canal of the Greeley-Poudre Irrigation District System. I testi-
4366 fied that the sum total seepage from the canal would be large on account of its length and formations through which it passes. I would think a loss of 46% would be excessive.

In that testimony, in a general way, I attempted to compare the Poudre Valley Canal with the Laramie Plains work.

Am familiar with the fact that in the year 1903, after a critical and careful examination of seepage of water from the Pioneer Canal of the Laramie Plains system of irrigation works had been made by Professor W. P. Fleming of the Wyoming Experiment Station, it was determined that over 46% of the water entering the headgate of that canal is lost by seepage.

R. I. MEEKER.

Redirect examination by Mr. N. E. Corthell:

4367 The photograph (Plaintiff's Exhibit W-1) was made in 1912 (not by myself). It shows the concrete diversion dam of the Pioneer Canal Enlargement, which is used as a measuring station for water. The view is taken looking up the river, showing the Jelm Mountain in the distance and showing also the weir across the river described in my testimony. The measuring station has been maintained there in this condition since early in 1912. All the water in the river, except the diversion of the Pioneer Canal Enlarge-
4368 ment passes over the dam. I made another photograph (Plaintiff's Exhibit W-2) of the same dam, showing the conditions during the winter, when ice prevails, and how it was cut back from the crest of the dam in order that we might have a free flow to secure accurate records, which conditions have been maintained throughout the winter season of 1912-13 and in 1913-14.

The picture (Exhibit W-3) shows the concrete bifurcation structure across the Pioneer Canal Enlargement in the lower end of Sodergren Lake, and one gate shown in the abutment to the right regulates the water in the old Pioneer Canal, and the other gate to Lake Hattie Supply Canal No. 1 and Lake Hattie Reservoir.

The picture (Exhibit W-4) made by me shows the concrete diversion dam of the Bellamy Canal in the Little Laramie River 800 feet above Wright's Ranch or Filmore post office.

The picture (Exhibit W-5) shows the concrete outlet gate of the James Lake Reservoir.

4369 The picture (Exhibit W-6) shows the earth dam with concrete facing at the Carroll Lake Reservoir and also the outlet gate, which is of concrete with a steel gate.

The picture (Exhibit W-7) shows the old log crib and rock diversion dam of the Wheatland Canal on the Laramie River now abandoned.

The picture (Exhibit W-8) shows the log crib and rock fill section of the Wheatland Tunnel Diversion Dam, now used.

The picture (Exhibit W-9) is concrete diversion dam and head works of Wheatland No. 2 Canal from Sybille Creek.

4370 I visited the Upper Rawah Ditch on July 24th, 1913, making measurements of the capacity of the constructed portion and several sections of the prism at the lower end and at other places, from which data and the grade given in the statement of the Rawah Ditch, State Engineer's No. 5448, 15.84 feet per mile, I have made two computations of two sections in the last 2,000 feet above the point where it drops down the mountain side to the west fork of the Laramie River. This capacity I determined at 2,000 feet above the end to be theoretically 115 second feet with an allowance of 1½ feet for free board, which is a little less than would be used in practice. At 1,000 feet above the end, 96 second feet. In actual operation of mountain ditches they rarely ever carry their theoretical capacity so I would say the present lower end of the ditch would carry less than 100 feet in practice. From my inspection of part of the irrigated lands in the Poudre Valley made April 20-23, I determined over an area of 100,000 acres the extent of the area of exposed water surface, which is 7,500 acres in reservoirs and ponds.

4371 Cross-examination by Mr. Fred Farrar:

This examination is same one made in same manner described in my testimony relative to headworks of ditches on Poudre River (pages 4144 to 4192 inc.).

No additional time was given to examination for purpose of determining exposed water surface. It was another of the items which entered into purpose for which I entered Poudre Valley.

I do not know how much of the 7,500 acres of exposed water surface represented water which was in active storage.

The dead or inactive water surface constituted but a small portion of the total.

Carroll Lake Reservoir is located in sections 31 and 32-17-74, just above rim of Big Basin and derives its water supply from Little Laramie River through Carroll Ditch. Ditch may have another name, am not positive. Cannot tell when reservoir was constructed.

4372 It covers by estimate about 70 acres and has capacity of less than 500 acre feet. This reservoir has been utilized for irrigation within past few years. Did not visit it in 1913. Picture shown in exhibit was taken May 18, 1914. It was not filled at that time. Water was below concrete and steel outlet shown in picture of dam. Water was probably a foot below outlet ditch. Only evidence I have of filling in prior years is high water marks shown on reservoir. Reservoir is of comparatively recent construction. Should judge it was constructed in last four or five years from nature of concrete and everything.

Referring to my Exhibit T-1, same being discharge curve, distance to right indicates greater capacity or greater flow. Curves indicating capacity or flow progress to right. Since introducing this in evidence, I have platted on area curve a second curve indicated by dotted or dash lines. That curve was drawn in order to show approximate location of area and mean velocity curves which would be based on high water measurements of Professor Carpenter, without taking into consideration the standard cross section of other measurements.

Some of Professor Carpenter's measurements as indicated
4373 by points on this plat, are on one side and some on the other of the curve which I have indicated by the dotted line.

A line drawn to indicate measurements shown by other records would approximate curve which I have platted and indicated by dotted line, without consideration of standard area curve. In case of mean velocity curve it would show mean velocity in excess of general trend of mean velocities or other discharge measurements.

A curve could be drawn covering general trend of all older measurements, except my own, but it would break at a gauge height of about three feet and in that distance two of measurements made by Professor Carpenter would show mean velocities in excess of five mean velocities determined from other measurements, the preponderance being in favor of the standard mean velocity curve as located by myself and used in computing the flow.

I base high area extension of velocity curve on group of mean velocities appearing from a gauge height of about 2.35 feet and covering or extending to 3 feet, measurements being made
4374 by others than Professor Carpenter.

A mean velocity curve could be platted based upon measurements other than my own and other than Professor Carpenter's, up to gauge height of approximately 2.75 and from that point on upward to highest point determined by Professor Carpenter. In other words to make a curve which would be to left of mine in vicinity of 2 feet gauge height crossing mine at about 2.75 and progressing to right of mine up to 3 or his height of 3.75 feet, but it would not be giving proper weight to other measurements. In fact, numerous mean velocity curves could be drawn in if a careful analysis of the mean velocities and areas were not made.

The area and mean velocity curves which I have adopted pass through measurements made by myself and are affirmed by measurements made by the U. S. Geological Survey and a number of other measurements.

My standard area curve lies to left of every point made by other persons than myself, but it should because as I have indicated, in other testimony, tendency of securing too high soundings during high water stages invariably results too great. I did not know that other hydrographers did not make proper computation of that, for reason I was unable to find any notes or data showing that other hydrographers had used standard area curves and areas
4375 which are secured from other measurements.

I have discarded all areas of discharge measurements for

the reason that they give values in excess of standard area curve, which is most accurate method of determining cross section. I have used these methods in working up data for a number of years and it was not resorted to in this case for a special purpose.

Whenever I have used the words "Standard Area Curve" I refer to area of velocity determined by myself and to curve derived from true cross section and not based on soundings at high water, which contain errors from factors entering discharge measurements as heretofore indicated. I am not assuming that other hydrographers have in each case either lacked the same skill that I have or were negligent in taking their soundings. I have made careful and rigid examination of data secured by other hydrographers and supplemented that by going into field and making special investigations. I have made no assumptions in the standard area curve. I have taken actual area curve.

Referring to Exhibit W-1, structure at end of Pioneer Canal was completed in winter of 1911-12.

Outlet of Lake James shown on Exhibit W-5, I am unable to give date of construction. I think it was prior to Pioneer con-
4376 struction just mentioned.

Structure on Sybille Creek at head of Wheatland No. 2 Canal was built in spring of 1913.

Dam in Little Laramie River at head of Bellamy Canal shown by Exhibit W-4 was constructed October 1912.

Bifurcation works of Pioneer Canal Enlargement shown by Exhibit W-3 was constructed prior to 1912.

In making record of stream flow where staff gauge is used, it is customary to read the gauge twice each day. For a rational expenditure of time and money this method gives sufficient data. Practice is to read it in morning and evening. Readings are ten or twelve hours apart. I was not aware of fact that Mr. Oviatt transmitted his staff gauge readings at Boswell Station to the State Engineer of Wyoming.

4377 Cross-examination by Mr. Delph E. Carpenter:

Capacity of Rawah Ditch would be greater by allowing one foot free board instead of one and one-half foot free board. Parties owning ditch might decide to attempt to run water using freeboard of six inches or a foot but they would have disastrous breaks and would have to come down to freeboard of one and one-half feet. Experience will tell in each case. As matter of fact a number of mountain ditches that I have examined, actual carrying capacity is approximately 50% to 60% of their theoretical carrying capacity.

R. I. MEEKER:

Redirect examination by Mr. John D. Clark:

4378 The errors in Plaintiff's Exhibits B, I and T-7, corrected above, did not occur in the measurements, but in the computations of the distribution, and in adding the amount to make

correction as to the use of water below Two Rivers. It alters the amounts of water charged to ditches below Two Rivers, the Wheatland No. 2 Reservoir, but it does not alter the volume of water distributed, or affect or change the deductions and measurements secured at Lookout Bridge. My testimony as to inflow into the reservoir was based on independent measurements taken at that bridge. Chugwater Creek passes along the eastern boundaries of the Wheatland tract through a depression at a considerable distance below the mesa land included in that tract, roughly, at least 200
4379 feet. It is also a considerable distance below the lands embraced in the Bordeaux tract, and the run-off from Chugwater at a point where it would be possible to divert it to those tracts is very small, being chiefly used for bordering meadow lands.

4379 Recross-examination by Mr. Fred Farrar:

Water from Chugwater Creek, while possibly not available for lands actually included within territorial limits of Wheatland tract, nevertheless is available for irrigation of land within state of Wyoming and adjacent to or in the general neighborhood of Wheatland.

R. D. STEWART, a witness in behalf of Complainant.

4380 Direct examination by Mr. N. E. Corthell:

Chief engineer and superintendent of the Laramie and Hahns Peak Railway Company since 1902, and acted in that capacity during the construction of the railroad across the mountains between Centennial and Walden in 1909, 1910 and 1911. The railroad extends 110 miles from Laramie, Wyoming, to Coalmont, Colorado, crossing the Medicine Bow Range of mountains at Fox Park, altitude 9,200 feet. The railroad enters the mountains from the north side at Spring Creek station at mile post 35 from Laramie and winds through the mountainous region to Northgate at mile post 80; the mountains extend along the Laramie River to its
4381 headwaters. The construction work on the railroad was prosecuted during the winter seasons of 1909-10 and 1910-11, and some work was done at Lake station about mile post 47 during the winter of 1908-09. This work consisted of rock excavation and cost the same as work prosecuted in the summer. The winter work was voluntary on the part of the contractors. I have been up to the Laramie-Poudre Tunnel on the Laramie River and know the nature of the country between Laramie and that section, and think that the Skyline Canal was pointed out to me from the tunnel site. In my opinion it would be entirely practicable to carry on rock work in the construction of ditches during winter seasons without
4382 adding to the cost more than what snow shoveling might occasion, which is not a burden.

4382 Cross-examination by Mr. Fred Farrar:

Snows encountered in going over mountains with the Laramie-Hahns Peak Railroad in 1909-10-11 during winter months were

from approximately three to four feet on level. Road was built from Laramie out. At time we were working on hill, road was constructed to within 15 miles behind at times. At other times it would reach the end and would be close to us. In one instance the winter work was done approximately and another about five miles ahead of the railroad. I should judge we had about forty men working in winter all in one camp. That was true of each winter we
4383 were working there. They were doing rock work entirely. Snow was shoveled out of way of embankments and of course in cuts very little attention was paid to it.

I was in vicinity of Greeley-Poudre tunnel once. It was during summer months of 1910. I went up in automobile from Laramie.

Cross-examination by Mr. Delph E. Carpenter:

Engineers who have had charge of construction work in vicinity of Greeley-Poudre Tunnel and Sky Line Ditch of Water Supply and Storage Company would probably know more about conditions there than I would, as to winter work. Would not say that work in vicinity of Greeley-Poudre Tunnel would vary very ma-
4384 terially from other mountain work at similar altitude. I am judging from my knowledge of mountain work.

Those who have been engaged in construction of that work in that immediate vicinity and who have encountered the difficulties there, would know more about the conditions at that particular point than I would.

Redirect examination by Mr. N. E. Corthell:

The railroad company hauled up a car or two, carrying an outfit in latter part of January, 1914. They said they were going to the Greeley-Poudre Tunnel.

(Mr. Carpenter: We object to testimony of witness along lines indicated by question for reason that it is not proper rebuttal and is not best evidence of what happened in connection with transportation of party to tunnel.)

Weather and snow conditions were somewhat more severe than usual.

4385 Recross-examination by Mr. Fred Farrar:

We unloaded this outfit at station called Wycola at milepost 67 out of Laramie. Do not know whether or not that particular outfit ever got to tunnel. Would consider it unreasonable that they killed two horses and consumed five days in going five miles in getting to tunnel. Nevertheless I was not in there. I was on Hahns Peak Railroad at various and sundry times. I was probably 25 miles from tunnel. Wycola is 25 or 30 miles from tunnel. Wycola reached Laramie River by Boswell's Ranch. It is about 8 miles from Boswell's. That is nearest point to railroad station.

Laramie, Hahns Peak and Pacific Railroad was open for busi-

ness across mountains October, 1911. It operated all winter 1911-12. In keeping road open we have to run rotaries in front of trains always. There is a rotary in front of every train. We run trains every alternate day during winter. There have been times when we have had accidents and got on ground in which case we were tied up for 2 or 3 days. We have been blocked for considerable time on account of accidents, getting on ground by rails spreading or something happening. We were never blocked by snow on account of fact rotary plow was able to keep road open.

4387 Recross-examination by Mr. Delph E. Carpenter:

I do not know anything about the hardships this party endured which unloaded to go to tunnel in winter of 1914. Do not know anything about enormous expense in getting there. Have no idea of amount contractors lost by being forced to go in there in winter time. I know that snow conditions were not the same in 1911 in winter as they were in winter of 1913-14. I do not know anything about Upper Laramie River Valley above Boswell's Ranch.

R. D. STEWART:

Redirect examination by Mr. N. E. Corthell:

4387 For years prior to the building of the railroad over the mountains, freight was commonly hauled over the mountains every winter.

GEORGE TRABING, a witness on behalf of Complainant.

Direct examination by Mr. N. E. Corthell:

4388 Have lived at Laramie, Wyoming, 35 years. The stage line from Laramie to Walden, Colorado, crosses the mountains between Boswell's on the State line between Wyoming and Colorado and Pinkhampton, Colorado. I was contractor on the line about eight years ago for three years until the railroad got into that country. The stage line ran daily each way and I went over the line once a month to do the collecting. It ran regularly each winter and I don't think they missed a trip the last twelve
4389 years until we had it, and then we had two or three failures of single trips. The road was generally traveled and freight hauled over it through the winter. There was also a stage line running up the Laramie River valley from Jelm to Gleneyre, and a Post Office beyond at Glendevey, to which mail was served from our line connecting with line at Boswell's. This stage line ran up the river and I took charge of it. I had a contract running from Laramie to Gleneyre until we were cut off at Walden four years ago. The line above Gleneyre ran three times a week. I do not think we missed a trip to Gleneyre and the mail was taken
4390 from there by contractor named Thompson to Glendevey. I have been to Chambers Lake twice, the last time about twelve years ago. We traveled through Sand Creek Pass and up the Lara-

mie River and over the divide at the headwaters. There was at that time a good road running up the river to Chambers Lake. I was there about August on a camping trip. I think it would be practicable to travel on a sled in and out of that country generally in the winter season, the same as they do in North Park and to carry on work there. We have had experience at different kinds of team work carrying the mail to Keystone and Holmes and to mountain camps fully as high as it is up there. Our road is a winter road over the same range of mountains farther north.

4391 Redirect examination by Mr. N. E. Corthell:

When I was over at Chambers Lake there were ranchmen living above Glendevey.

4391 Cross-examination by Mr. Fred Farrar:

Don't know pass over which I went from Boswell's to Pinkhampton, we go through what they call Mountain Home Park. It is at a low depression in the main mountain range. I think it undoubtedly possible to go up Laramie River on sleds in winter time.

Cross-examination by Mr. Delph E. Carpenter:

They work all winter long in vicinity of Keystone, Wyoming. It would be perfectly practicable and feasible to work all winter long on ditches taking water from Douglass Creek over into Little Laramie River.

Redirect examination by Mr. N. E. Corthell:

At time I went over to Chambers Lake there were ranchmen living above Glendevey. That was about 12 years ago.

Recross-examination by Mr. Delph E. Carpenter:

Keystone, Wyoming, is on Douglass Creek. I do not know whether or not that is where Laramie Water Company are constructing ditch from Douglass Creek over into Little Laramie River. Keystone is almost west from Centennial Valley, just over range of mountains. Keystone is located on Section 22-14-79. It is very close to top of range west of Laramie Plains, because it is on river that flows other way, kind of on headwaters of Douglass Creek which flows other way, so you virtually cross range to get to it.

GEORGE A. CAMPBELL, a witness in behalf of Complainant.

Direct examination by Mr. N. E. Corthell:

4393 Have lived at Laramie, Wyoming, about 32 years and I am secretary of the Laramie River Association, an organization composed of people in the Laramie Valley formed for the purpose of resisting diversion of water from the Laramie River in Colorado out of the water-shed.

I wrote a letter dated March 25th, 1910, to the United States Investor, Boston, Mass., a copy of which, aside from the address, is incorporated in the record in connection with the testimony of William Iliff (Page 232, Vol. 5, Defendants' transcript). I have the clipping referred to in the letter which was published in the
4394 Pierce Record, Pierce, Colorado (in the Greeley-Poudre Irrigation District) March 24, 1910. This clipping is as follows:

"Financial Inquiry.

The following from the United States Investor, Boston, shows the esteem in which Greeley-Poudre Irrigation District bonds are held in the New England metropolis:

Municipal 6% Bonds.

20559.—(Concord, N. H.) Kindly advise me as to the value and reliability as an investment of the municipal 6% irrigation water bonds of Weld County, Colorado, Greeley and Poudre district. What is your opinion of this class of bonds in general?

Ans.—We consider this issue of irrigation bonds one of the best which we have had occasion to investigate. The Greeley-Poudre irrigation district is a municipal corporation, organized under the laws of Colorado, and embracing 125,000 acres, immediately adjacent to the famous old irrigated Greeley district, one of the richest agricultural districts in America.

Land values under irrigation in this district are advancing steadily; crop failures are unknown, and climatic and soil conditions are particularly favorable for the raising of potatoes, sugar beets, alfalfa, etc.

Long before there was any irrigation undertaken in this district, the Union Pacific railroad built through it, and since then has built branches with the sole intention of serving the district. The land is being rapidly taken up, and there is no point in the district more than four miles distant from the railroad on which the Union Pacific has already spent more than $2,000,000. The Chicago, Burling- and Quincy Railroad has surveyed and contemplates building directly through this district next year.

These bonds are municipal bonds, and are a prior lien over any subsequent issue by the District. Without exception, there has never been a default in the interest or principal payments on Colorado municipal district bond issues. We have no hesitancy in recommending these bonds.

As a general rule, this class of bonds are a good investment, but in each particular issue of irrigation bonds careful investigation should be made before purchase."

4395 I produce copies of two circulars (Plaintiff's Exhibits V-1 and V-2) then in circulation by Farson Sons & Company, advertising these bonds.

4396 On Tuesday of this week (May, 1914), I visited the site of the Greeley-Poudre Tunnel at the Laramie River, where I saw eight men working, cleaning out the cut, removing the earth and rocks from the portal of the tunnel. No water had been diverted. About 100 feet to the north of the entrance to the cut leading to the tunnel there was a crib made of logs that had been placed across the channel of the stream, four logs high, but nothing put into the crib to prevent the water flowing through so it checked the flow of the stream very little. When filled this crib would have the effect of diverting water from the river into the tunnel. The crib was quite a long distance above the permanent dam. I don't
4397 know the exact distance but it is near the opening of the cut from the river to the tunnel, something like half a mile above the permanent dam. Nothing has been done on the latter work since the fall of 1910 that I could discover, and it is incomplete, some of the work put in having been washed out.

N. K. Boswell, a witness in behalf of Complainant.

4398 Direct examination by Mr. N. E. Corthell:

Have lived in the Laramie Valley since '68, having owned since '69 a ranch at the Wyoming-Colorado line. I have been familiar with the conditions in the valley at that ranch and above since I have been living there. There is a well-traveled road running up the river to the Chambers Lake district, which has been traveled a great many years. In fact since they trailed through there in '69 logging up there and cutting timber on the Laramie River in '67 and '68. Poles and timbers have been cut up along the river to Glendevey since that time, and a tie camp was maintained
4399 in that neighborhood since '67. The river valley above my place is pretty well settled for about twenty miles up to not far from the tunnel. There has always been travel about twenty miles above my place to Glendevey and thereabouts through the winter season, people haul in supplies, the mail is carried to Glendevey almost every day, and there is nothing to prevent communication to the tunnel in the winter season. There is considerable snow there but nothing to prevent work. In the logging camps and tie camps work was carried on in the winter season. This
4400 includes the region where the ditches lie.

Cross-examination by Mr. Fred Farrar:

Ties are run down from there. They are floated down river. Mail goes in above Boswell's on sleds most of time during winter. It goes as far as Glendevey. Could not say how many people live between Glendevey and tunnel during winter months, have not been up there for quite a number of years. People generally take in their supplies for winter in the fall. They take them in the fall because they can get them in better in fall than in winter. Snow is pretty deep there but there has been no time in a great many years but what they could get up to Glendevey.

4401 *Stipulation.*

It is stipulated in open court between counsel for the parties litigant, that photographic reproductions of any of the maps and similar exhibits offered by the parties to this proceeding may be substituted and used in lieu of the originals as offered and introduced during the taking of the testimony and shall be labeled and marked by the respective commissioners as are the originals; except in cases where the substance of the exhibit cannot be shown by photograph.

Stipulation.

It is hereby stipulated and agreed by and between the parties hereto that all evidence in this action was offered at times mutually agreed upon between the parties hereto, and that the said parties mutually agreed and assented to the periods of time occupied by the Defendants and by the Plaintiff in the presentation of the evidence on behalf of the Defendants and on behalf of the Plaintiff in rebuttal respectively, and that any and all objections to the time when such evidence was presented are hereby waived.

And this was all of the testimony offered on behalf of the complainant.

(End of Transcript, vol. 9, Complainant's Rebuttal.

[Endorsed:] Supreme Court U. S. October term, 1915. Term No. 7, Original. The State of Wyoming, Complainant, vs. The State of Colorado et al. Abstract of Evidence. Filed June 5, 1916.

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Supreme Court of the United States

OCTOBER TERM, 1916

No. [redacted]

THE STATE OF WYOMING, COMPLAINANT,

vs.

THE STATE OF COLORADO, THE GREELEY-POUDRE IRRIGATION DISTRICT, AND THE LARIMER-POUDRE RESERVOIR AND IRRIGATION COMPANY, DEFENDANTS.

IN EQUITY

Brief on Behalf of the Plaintiff

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Of Counsel.

[illegible] Co., Printers, Washington, D. C.

Supreme Court of the United States

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SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1916

NUMBER 7 — ORIGINAL

THE STATE OF WYOMING, *Complainant*,

vs.

THE STATE OF COLORADO, THE GREELEY-POUDRE IRRIGATION DISTRICT, AND THE LARAMIE-POUDRE RESERVOIRS AND IRRIGATION COMPANY, *Defendants*.

IN EQUITY

BRIEF ON BEHALF OF THE PLAINTIFF

I.

STATEMENT OF THE CASE

This is a suit by the State of Wyoming against the State of Colorado and two individual defendants incorporated under the laws of that State, growing out of questions of the use of water from the Laramie River, which has its source in Colorado and flows into Wyoming.

The Bill alleges that in 1865 the settlement of the valley of the Laramie in Wyoming began, and

from that time on to the time of the commencement of the wrongs complained of the settlers in the valley of the Laramie in Wyoming had improved and by the practice of irrigation had rendered highly productive the lands in that valley in Wyoming, and had built up there a community of twenty thousand people, irrigating three hundred and twenty-five thousand acres of land.

It is alleged that these lands without the artificial irrigation are so arid in character that they are unproductive; that the citizens of the plaintiff had built the City of Laramie within the valley of the stream, and the plaintiff had established there its State University; and the community, the City, the University, the real values of the lands, are all dependent upon the use of the waters in controversy; that by the practice of irrigation the lands within the valley have become worth a large amount, to-wit, more than ten millions of dollars.

The Bill alleges that it has become established by the customs, laws and decisions of both Colorado and Wyoming that the waters of all streams, subject to any prior rights that may exist, are open for appropriation and use for irrigation purposes; that priority of appropriation gives priority of right.

The Bill further alleges that the mountains at the head of the Laramie River where very heavy

banks of snow fall in winter are within the State of Colorado, and that it is these heavy banks of snow in Colorado which supply the waters of the stream, the valley of the Laramie in Wyoming being arid and furnishing little water.

It is further alleged that notwithstanding the prior appropriation of the water by citizens of Wyoming, the defendants are threatening to pierce the walls of the water-shed by a tunnel through the mountains, and to carry away the waters of the stream to the amount of more than one hundred thousand acre feet per annum, (an acre foot being such amount of water as will cover one acre of ground to a depth of one foot), to a point more than one hundred miles away from the Laramie Valley and from which no part of the waters can return.

It is further alleged that if this threat is carried out, it will destroy the value of the lands within the water-shed of the Laramie River in the State of Wyoming, and will destroy the community which has been built up there.

The answer of the State of Colorado denies that the run-off from the heavily timbered mountainous area in Colorado at the head of the Laramie River supplies all of the waters of that stream.

Alleges that not more than 100,000 acres of the

drainage area of that river in Wyoming are productive under irrigation of which 50,000 acres lying between the Colorado line and the Wheatland reservoir are of inferior quality, unproductive, adapted to raising only limited crops. That the lands comprising the other 50,000 acres have some productivity, but that the greater part of the irrigation rights for these are junior to the rights of defendants.

Denies that the doctrine of the right to the continuous flow of the river ever obtained in Wyoming.

Admits that prior to the commencement of defendants' irrigation system, some of the lands along the Laramie River and its tributaries had been settled on, improved and rendered more productive by irrigation therefrom, but avers that the run-off was abundant to supply plaintiff and defendants.

Denies that plaintiff's lands would be rendered valueless without the water, or that more than 2,000 people are supported by their irrigation or that more than $500,000.00 had been expended in Wyoming in the development or use of the waters prior to the initiation of the defendants' rights.

Admits that certain of the waters are used by towns and villages in Wyoming, but avers that the run-off is sufficient for such needs and the needs of the defendants.

Admits certain appropriations from the stream

prior to the commencement of defendants' irrigation system, but avers that the run-off is sufficient for both.

Avers that the rights of defendants were initiated August 25, 1902, when there was abundant water to supply prior appropriations.

Denies that plaintiff and its citizens had appropriated all the waters prior to the threatened diversion.

Avers that at no time had more than 50,000 acre feet annually been taken from the stream for use in Wyoming prior to the initiation of defendants' rights, and that the annual run-off from Wyoming lands is more than 500,000 acre feet and the total annual run-off of the stream is more than 800,000 acre feet.

Denies that defendants are threatening to divert from the stream more than 100,000 acre feet, but avers entire diversion cannot exceed 70,000 acre feet annually.

"Defendant avers that the State of Colorado is the owner of all waters within said State of Colorado with the full right to dispose of them as it may choose and denies that such rights are subject to the rights acquired by the complainant and its citizens as alleged in the bill of complaint; avers that it is the right of the defendant commonwealth to dispose of the waters of that portion of said stream lying within the State of Colorado without let or hindrance by

the complainant or its citizens; and defendant avers that the defendant commonwealth can so dispose of the waters of said stream regardless of the prejudice that it may work to the complainant or its citizens within the State of Wyoming, and need give no reason for its will."

SECOND. The second division of the answer, apparently intending to constitute a second defense, alleges the sovereignty of Colorado as a State; that the Laramie River arises in that State; that the region within the boundaries of the State of Colorado is the apex of the Continental Divide, and therefore that streams flow from Colorado in every direction; that Colorado has the plenary and exclusive right and power to control and regulate its non-navigable waters; that the streams arising in the State "after leaving the mountains in which they originate, flow across lands of a nature usually described as plains, and from which, owing to the lack of rainfall, these streams receive no additional supply of water, but, on the contrary, the water in said streams is very rapidly diminished by evaporation and by absorption by the soil through which they pass;" that these lands are unusually fertile and when irrigated produce unequaled crops; that the Laramie River is a stream having its source in Colorado, from which it flows

into Wyoming; that said stream is not navigable; that the use of the waters of the stream by irrigation within Colorado is essential to the life and well-being of the inhabitants of a large area within Colorado, and the right of continued use of the waters is as vital as is the land itself; that Wyoming has no jurisdiction over the lands or water in Colorado; that under the laws and principles of international and interstate law the sovereign rights of Colorado over the waters of the river are not subservient to the sovereignty or rights of the State of Wyoming; that the State of Colorado cannot be subjected to the burden of arresting its development, or of denying to its inhabitants the use of an element which nature had supplied entirely within its own territory, and that without the free use of the water the lands to which said water is sought to be applied would be uninhabitable.

THIRD. The third division or defense of the answer alleges that the annual run-off of that portion of the drainage area in Colorado is 300,000 acre feet, and of that portion within Wyoming is 500,000 acre feet; that the diversion system sought to be enjoined could not divert more than 70,000 acre feet annually, nor could more than 90,000 acre feet annually be diverted from the stream in Colorado; that the predecessors of the defendants conceived and began the construction

of a large irrigation system on August 25, 1902, for the purpose of conveying 70,000 acre feet of the water of said stream to a body of 125,000 acres of land in Weld County, Colorado, and since have constructed a collection system for gathering the waters, a reservoir for impounding it and a tunnel of 12,000 feet in length for carrying it through the mountain range, all at an expense of about $1,200,000.00; that the Greeley-Poudre Irrigation District was formed under the laws of Colorado for the purpose of irrigating said 125,000 acres of land; that bonds of the District for that purpose have been voted and issued to the amount of $5,000,000.00 par value, of which $2,700,000.00 have been used and $2,300,000.00 are still available in the treasury of the District; that citizens of Colorado have filed upon large bodies of public lands of the United States, relying upon the use of the water, and have made valuable improvements upon said lands; that the use of the water would enhance the value of the land about $50,000,000.00, and if denied that the value of the lands would be largely destroyed and the acquisition of title from the Government defeated; that at the time of the initiation of the defendants' rights there was an abundance of water in the river to supply all rights to water existing in the State of Wyoming which had their origin prior to the inception of the defendants' rights; that the lands in

Wyoming to be irrigated are inferior in productiveness to the lands in Colorado, and also require a greatly increased quantity of water over the necessities of the lands in Colorado, and that irrigation of the Wyoming lands will produce less returns than of the Colorado lands.

The corporation defendants joined in an answer, the first defense of which is in all material respects identical with the first defense of the answer of the defendant The State of Colorado.

The second defense likewise in the answer by the corporations, while stated in different language, bases the defense on the sovereign right of the State of Colorado to the use of the water within the State regardless of the rights of neighboring states and their citizens. It seeks to buttress this claim by quotations from the Constitution of Colorado.

The third defense is the same as the third defense in the answer by the State, with the addition of averments supposed to set up an estoppel. These additional averments are as follows:

> "Defendants aver that the plaintiff and its citizens, long prior to the institution of this suit and at all times, were fully advised of the said diversions and proposed diversion of these defendants and their predecessors in title, and have been advised of the formation of said district, of the voting of the bonds thereof, of the

sale of said bonds to innocent purchasers for value, of the said construction for the purpose of effecting said diversion, and of the steps taken by citizens in said district in reliance thereon.

"Defendants aver that plaintiff and its citizens are equitably estopped from questioning the diversion sought to be enjoined herein."

Answer of the corporations, page 17, line 28, to page 18, line 6.

The fourth defense of the answer by the corporations sets up matters which seem to us in effect the same as those stated in the third defense, excepting that the matters in estoppel are not contained in the fourth defense.

The plaintiff filed the general replication.

Inasmuch as the evidence will be discussed somewhat at length in another portion of this brief, we deem it sufficient here to confine ourselves to a brief general statement of some of its salient features.

The Poudre Valley in Colorado is very fertile. Irrigation began there quite early in the history of the Rocky Mountain region and has been carried on with such success as to make out of that valley a wonderful garden spot. In this work of irrigation they have constructed many reservoirs and ditches and have used more nearly the total flow of the Poudre River than has been accomplished in the case of any other river in the region. Besides they have dug

through the walls of two near-by watersheds and have brought into their valley the strange and unaccustomed waters of two other streams, Grand River and Michigan River, which do not by nature mingle their waters with those of the Poudre. All of these things they have been able to accomplish at great expense because the lands of that valley are highly productive and of great value, and therefore have furnished them the necessary means and will abundantly repay the expenditure.

On the other side of the mountains from the Poudre is a mountainous area at the very crest of the continent. It is an area of heavy winter snows which constitute the real source of the Laramie River. This river, gathering its waters from numerous confluent streams in these mountains, naturally carries its water out of the mountains and upon the Laramie Plains. These plains are arid, with very light rainfall and porous, gravelly soil, and through evaporation and seepage into the thirsty soil the volume of water in the river naturally decreases mile by mile along the one hundred and fifty miles of the river's length in Wyoming.

Beginning in 1865 and continuing through the years since, the citizens of Wyoming have diverted waters from the river for the irrigation of lands on these plains.

These lands without the use of the water are unproductive. Indeed with irrigation they are far less productive than the lands in the Poudre Valley in Colorado, and therefore will not in anything like as large measure repay the husbandman for his expenditures and his toil in diverting the water from the stream and applying it upon the land.

Nevertheless the people of the Laramie Plains have been able to increase largely the yield of their lands through the use of the waters of the Laramie River and have built within the watershed of the river prosperous communities.

The inhabitants of the Poudre Valley in Colorado, finding they could not irrigate all the lands which they desired to irrigate even though using so much of the flow of the Poudre as it was found practicable to utilize, plus the waters of the Grand River diverted from its own watershed into the Poudre, plus the waters of the Michigan River diverted from its watershed into the Poudre, plus waters already diverted from the Laramie River and carried into the Poudre, sought additional waters that they might further extend their beautiful and lucrative garden. They found that by the use of a long tunnel through the mountains and certain intercepting ditches it would be physically possible to intercept and carry from the Laramie River into the Poudre a large volume of

additional waters, and they began their preparations to take this water. Thus far all the evidence agrees.

The defendant contends that the amount of water possible to be taken will not exceed 70,000 acre feet per annum, the plaintiff contends that the amount will exceed 100,000 acre feet per annum.

We believe a clear preponderance of the evidence establishes that the citizens of Wyoming, long before the commencement of any proceedings by defendants to take the waters in controversy, appropriated the entire available waters of the Laramie River, and that the threatened diversion of these waters by the defendants will be disastrous to the plaintiff.

II.
BRIEF OF THE ARGUMENT

A. DISCUSSION OF THE EVIDENCE.

The Laramie River rises in the high mountains of the Continental Divide, about thirty miles south of the Wyoming-Colorado line, and flows northerly into Wyoming and thence in a general northeasterly direction about 150 miles to its confluence with the North Platte River, about thirty miles west of the point at which the North Platte River enters the State of Nebraska. The Cache la Poudre River starts at Chambers Lake upon the Continental Divide, the headwaters of the river being interlaced with those of the Laramie River, but it flows in a northeasterly direction on the east side of the Green Mountains, whereas the Laramie River flows on the west side of that range. A few miles north of its source the Poudre turns to the east and enters the South Platte River near Greeley, Colorado; the South Platte flows easterly to its junction with the North Platte near the town of North Platte, Nebraska, the two rivers forming the Platte, a tributary of the Missouri. About five miles north of their headwaters the Laramie

and the Poudre are divided by a narrow ridge of the Green Mountains, and through this ridge the defendant Laramie-Poudre Reservoirs and Irrigation Company, under a contract with the Greeley-Poudre Irrigation District, has driven a tunnel about 11,000 feet long for the purpose of diverting water from the Laramie River into the Poudre for use upon the lands lying within the boundary of the defendant the Greeley-Poudre Irrigation District, a municipal corporation. This district lies within the valley of the Poudre and the South Platte, from fifty to eighty-five miles east of the Green Mountains and north of the town of Greeley.

The Laramie Valley in Colorado is very narrow, being from one-half to perhaps two miles in width, and contains only a few ranches upon which there has been some inconsequential irrigation for hay. The few ditches are short, close to the river, and cover very small areas. Near the Wyoming-Colorado line the river enters a canyon from which it emerges about ten miles north of the state line upon what are known as the Laramie Plains, an area about seventy-five miles long and twenty miles wide, bounded on the west by the Medicine Bow Mountains, which constitute the western border of the Laramie drainage area in Colorado, and bounded on the east by low hills or mountains, an extension of the Green Mountain

range, but locally known as the Sherman Mountains or Black Hills. The elevation of the Laramie Plains varies from 7,000 to 7,500 feet, Laramie City, midway in the river's course across the Plains, having an altitude of 7,159 feet. At the northerly or lower end of the Laramie Plains the river turns easterly, passing through canyons in the Black Hills and thence through a narrow valley to the North Platte River at Fort Laramie.

The area of the drainage basin of the Laramie River is 4472 square miles, of which 395 square miles, or about nine per cent., lies in Colorado. This Colorado area, however, furnishes to the river a supply of water which both in quantity and in seasonal distribution of the flow is disproportionate to the area of the watershed in that State. The mountains of the Continental Divide at the headwaters of the river rise to an elevation of 13.000 feet, whereas the Medicine Bow Range on the west side of the Laramie Plains has an average elevation of less than 10,000 feet, and the Black Hills on the east side of the Laramie Plains have an average elevation of about 8,500 feet. The average annual precipitation at Laramie City is 10.2 inches, while the average annual precipitation in the mountains at the headwaters of the river reaches as high as forty inches, consisting principally of snow falling between September and May which is packed

and conserved so that the run-off is delayed beyond the period of the run-off of the lower areas, and contributes a supply to the stream when other sources have been exhausted, and during the period of greatest need.

The only important accession of the Laramie River upon the Laramie Plains is the Little Laramie River, rising in the Medicine Bow Mountains and of approximately one-half the size of the main river. Sand Creek is theoretically a tributary of the Laramie River on the east side, rising in Colorado and entering the river above Laramie City, but by reason of diversions therefrom into the Poudre Valley and the use of its water upon lands bordering it, Sand Creek for many years past has failed to contribute anything to the river. Aside from Sand Creek there is no stream of any consequence rising on the west side of the hills bordering the Laramie Plains upon the east. East of the Black Hills the Laramie River receives water from Sybille Creek, Chugwater Creek, and the North Laramie River. Chugwater Creek flows through a low valley which is irrigated to the extent that the amount of water in the stream permits, and enters the river close to its mouth. The same is generally true of the North Laramie River upon the north side of the Laramie, and water could not be obtained from either of these sources for the irrigation of the

lands now irrigated from the Laramie River. Sybille Creek is a part of the system of the Wyoming Development Company hereinafter described.

There are two principal irrigated areas along the Laramie River in Wyoming. Irrigation commenced upon the Laramie Plains at about the time of the construction of the Union Pacific Railroad in 1868. Most of the ditches are owned by individuals or by a small number of individuals, but within recent years two larger systems have been constructed—the Lake Hattie system and the Lake James system, the former incorporating the Pioneer Canal, originally constructed in 1879, and the first canal constructed for the purpose of serving others than the owners. The witnesses for the complainant itemized the numerous areas upon the Laramie Plains irrigated from the Laramie River in 1913, aggregating 70,000 acres, with 6,600 acres irrigated from Sand Creek and its tributaries, and 48,000 acres irrigated from the Little Laramie and its tributaries, a total of 124,600 acres. The witnesses for the defendants computed the irrigated acreage upon the Laramie Plains at 90,600 acres, the larger part of the discrepancy being due, probably, to the obvious difficulty of a stranger in determining the area irrigated by flooding the land for pasture purposes.

The other principal irrigated area is the Wheat-

land district, bordering the river upon the east side of the Black Hills, the construction of which was commenced by the Wyoming Development Company about 1883. The original system covered approximately 60,000 acres, lying south of the Laramie River, east of Sybille Creek and west of Chugwater Creek, but two additional units of 10,000 acres and 20,000 acres respectively, and known as the Bordeaux and Sybille units, were undertaken in 1908 and 1910. In 1913, 33,544 acres in the original tract were under actual irrigation and 1,004 acres irrigated in the Bordeaux tract; the Sybille project had not then been completed. The water supply for these lands is the Laramie River, which is diverted through a short tunnel into Blue Grass Creek in which the water flows to Sybille Creek, whence it is diverted into the several main canals. The enterprise encountered the usual exigencies of construction and colonization work, and settlers were not secured until about 1894, and in the first year when but a few hundred acres of land was being irrigated the settlers encountered a shortage of water and demanded of the company the construction of the reservoirs, offering to pay to the company an increased price above that stipulated in their water purchase contracts if the company would construct such reservoirs. This demand persisted, and in 1897 the company constructed a small reservoir within the

reclamation area, and this not satisfying the requirements of the settlers, in 1899 commenced the construction of the Wheatland No. 2 Reservoir upon the Laramie Plains, fifteen or twenty miles above the tunnel into Blue Grass Creek. This reservoir was completed in 1901. The plans of the locating engineer indicated a capacity of 120,000 acre feet (one acre foot being that amount of water sufficient to cover a superficial acre to the depth of one foot, and containing approximately 43,000 cubic feet.) No engineer who had computed the capacity of the reservoir as constructed from an actual survey of all contour lines was available as a witness, but the hydrographer of the plaintiff, from his detailed measurements of the inflow and outflow of the reservoir, and a survey of its high water mark, computed its active capacity at 83,400 acre feet, and its dead capacity, incapable of withdrawal, at 35,000 acre feet. This reservoir is a channel reservoir at the lower end of the Laramie Plains below the junction of the Laramie and Little Laramie Rivers, and below all other accessions of any significance, and necessarily stores all water flowing past the headgates upon the Laramie Plains, all water flowing into the river from gullies and small creeks, and all water returning to the river from seepage or overflow. It was definitely shown that since the completion of this reservoir in 1901

there have been but two years in which water has been permitted to flow past its dam and down the river, excepting for immediate diversion through the tunnel into Blue Grass Creek for use on the Wheatland tract. In 1907 the management became solicitous for the safety of the reservoir and opened the gates for a few days during the high water period. In 1909 the flow in the river was extraordinarily great, and the reservoir filled so rapidly that it was necessary to cut channels at one end of the reservoir to permit the water to escape and find its way back to the river. For several days a wide and very deep stream rushed from the reservoir, and the flow continued in some volume for several weeks. No estimate of the quantity of water so escaping could be made, but it must have been a very large amount. With these two exceptions this reservoir, for the thirteen years since it was constructed, has held and conserved for use upon the Wheatland area all of the water in the river at that point.

In November, 1909, eighteen months before the commencement of this suit, the Laramie-Poudre Reservoirs and Irrigation Company, under a construction contract with the Greeley-Poudre Irrigation District, commenced the construction of the tunnel from the Laramie River to the Cache la Poudre River, of which complaint is now made. The several de-

fendants allege in their answers that this project was initiated on August 25, 1902, and assert a priority of appropriation from that date, being anterior to the commencement of the construction work upon the Sybille and Bordeaux supplements to the Wheatland irrigation system, and antecedent in point of time to the commencement of actual construction work upon the two principal large enterprises upon the Laramie Plains hereinafter mentioned, the Lake Hattie and Lake James projects. It appears that about 1897 Wallis Link, a small ranchman in the valley of the Laramie River in Colorado, while hunting on the divide observed the comparative proximity of the two streams and conceived the possibility of a short tunnel through the mountain to divert water from the Laramie into the Poudre. It is the purport of the evidence for the defendants that the tunnel which was commenced twelve years later had its origin in this episode. In 1902 Link, having removed to a farm near Fort Collins, interested a neighboring farmer in the Laramie diversion project, which was given more tangible form through a series of surveys in 1902 and succeeding years and intermittent work on roads and a ditch, presently to be mentioned, up to the late months of 1909. The first survey by Link and his associate was made in 1902 for a ditch connecting with a previous ditch (the Skyline) which

had been built some years before by other parties to collect the waters, high up on the mountain side west of the sources of the Laramie and carry them in a southerly direction through a gap in the divide to Chambers Lake—an expansion of the Poudre River. Connecting their project with the upper end of the Skyline, Link and his associate extended their survey northwesterly to a series of small lakes high up on the western watershed of the Laramie, so as to drain the waters from these lakes and intercepted streams and convey them to and through the Skyline to Chambers Lake for use at such places in the Poudre Valley as might be found feasible and profitable. In 1904 a considerable amount of work was done on this ditch and in 1907 still more work was performed and some water was run in the ditch, but was not turned into the Skyline or put to any use. It was explained by the defendants' witnesses that it was the double purpose of the promoters to use and sell the water thus to be carried through this ditch—which at first passed by the name of the Link Lake Ditch and is subsequently referred to as the Rawah or Upper Rawah Ditch—and, with the revenue thus to be gained, to accomplish the much more ambitious project of diversion through the tunnel. In 1904, having admitted two more associates, Link made further surveys including several tunnel locations, and from

that time on until 1909, he and his associates or successors located numerous ditches, tunnels, dams and reservoirs, maps of which were filed from time to time in the office of the State Engineer of Colorado, all having for their purpose the diversion of the Laramie River waters into the Poudre or its tributaries. Apparently the latest of these locations examined, surveyed and projected was for a reservoir in the river some miles below the tunnel sites, with a ditch leading out of the Laramie Valley into Wyoming across Sand Creek and into Sheep Creek and the North Fork of the Poudre, which was to divert all and more water than could have been secured through the tunnel, convey it by a much longer and more circuitous route to the Greeley-Poudre District, and thereby water all of the lands embraced in the present project and a considerable additional tract to the north.

These various projects had this much in common, that they were all intended to divert—in varying amounts and by numerous and variant and in some instances by alternative means—the waters of the Laramie River to the Poudre Valley. They took no visible form, however, aside from the work on the extension of the Skyline Ditch, until near the end of 1909.

In the meantime, the application of these waters

to use was the subject of equally numerous, alternative, successive and variant projects. Starting with Link and his associate Akin, who had a scheme to use or market the water on their own farms or other lands in their neighborhood south of the Poudre, these projects, as the number and ambition of the associated promoters grew in subsequent years, expanded in size and floated about over the available sites for irrigation in the Poudre Valley until September, 1909, when the contract was drafted and submitted to the voters of the Greeley-Poudre Irrigation District, and being approved by them became effective October 4th, following which the visible and tangible works to divert the Laramie River water became fixed.

The irrigation system so contemplated was divided into two main divisions, the Laramie River or Mountain division and the Plains division. The Laramie River portion of the work consisted of the ditch upon which Link had commenced construction in 1904, and called the Upper Rawah Ditch, intercepting several tributary creeks and carrying their water into the west fork of the Laramie River; the West Side Collection Ditch, intercepting the same tributaries lower down, performing precisely the same service as the Upper Rawah Ditch and rendering that ditch of little or no value; the East Side Collection Ditch; a small reservoir in the channel of the river below the

juncture of the west fork and the east fork, and the tunnel leading from this reservoir. The function of the two collection ditches is clearly indicated upon the map "Exhibit B", attached to the bill of complaint; they start far north of the tunnel and high enough on the mountain side to give the necessary fall, and intercept the principal high mountain tributaries of the river, carrying their waters back to the tunnel reservoir; the tributaries so intercepted all enter the river below the tunnel and their waters could not be brought to the tunnel for diversion into the Poudre, were it not for these collection ditches.

The Plains division of the Greeley-Poudre system consists of an enlargement and extension of the Poudre Valley Canal, one of the existing canals on the north side of the Poudre River, so as to cover the lands within the new district, and a number of reservoirs to be used in furnishing the necessary storage for the water of the Laramie and for storing the surplus and unappropriated waters of the Poudre and its plains tributaries, aggregating, according to the report of the expert who examined the water supply for the proposed district, about 120,000 acre feet per annum.

It is alleged in the bill that the defendants intend to divert through this tunnel more than one hundred thousand acre feet per annum of the water of the Laramie River; in the answers it is admitted that the

tunnel has been constructed for the purpose of diverting 70,000 acre feet per annum. In the elaborate report of Professor L. G. Carpenter, who in 1909-10 investigated the water supply and who acted as the irrigation expert on behalf of the defendants in this case, it was stated (marginal page 3934) that the total available supply from the Laramie watershed was 70,160 acre feet per annum. The principal evidence upon this matter was given by the State Engineer of Colorado, Mr. Field, who concluded (p. 3420) that the mean annual flow in the Laramie River and the tributaries intercepted by the collection ditches leading to the reservoir, at the tunnel after upper diversions had been made was approximately 77,000 acre feet; that by reason of the porous condition of the mountain collection ditches and the impossibility of using them during the winter months, not more than seventy-five per cent. of this flow could be turned into the tunnel reservoir, so that the mean annual diversion through the tunnel would be 56,000 acre feet; he further testified that if an extension of the West Side Collection Ditch were made to McIntyre Creek as contemplated but not presently intended, an additional amount of 15,000 acre feet could be procured, making a total possible diversion of 71,000 acre feet per annum through this system. To this he added 18,000 acre feet as the average annual

diversion from the Laramie River into the Poudre through the Skyline Canal, and 2,000 acre feet as the average annual diversion from several of the east side tributaries of the Laramie into the Poudre through an earlier ditch known as the Divide or Wilson Supply Ditch, which carries water around the northern end of the mountains constituting the eastern boundary of the Laramie River drainage area. This makes the total actual and contemplated diversion from the Laramie into the Poudre, 91,000 acre feet, unless, of course, the ditches are lined with concrete or otherwise improved so as to carry water without such great loss.

These facts constituted the foundation of the plaintiff's case. They show that a very large area of arid lands in the State of Wyoming have been reclaimed through the use of the water of the Laramie River; that with the exception of 1907 and 1909 when water was permitted to waste from the Wheatland reservoir it has been found necessary as a matter of practice to conserve and use the entire flow of the river for such irrigation; and that the defendants, having already diverted 20,000 acre feet per annum from the river for use in another watershed, are now attempting to divert an additional amount of from 56,000 to 71,000 acre feet, all of which will be com-

pletely lost to the valley of the Laramie, as no seepage or return flow therefrom would be possible.

To meet this case the defendants have offered evidence to show (1) that the use of the water in the valley of the Poudre will yield immensely greater returns because that valley is a remarkably rich and fertile farming territory, whereas it is contended the Laramie Plains is practically worthless for farming purposes; (2) that after the Colorado diversion there would be abundant water in the Laramie River and its tributaries for the complete irrigation of the Wyoming lands now under irrigation; and (3) that through the storage of water in reservoirs in Wyoming an ample supply can be obtained irrespective of the Colorado diversions.

A very large part of the evidence is given over to a description of the beauties of the Poudre Valley, and the desolate aspect of the Laramie Plains. The former has an average elevation but little in excess of 5,000 feet; the latter, lying fifty miles to the north, has an average elevation in excess of 7,000 feet, and the agricultural conditions are undoubtedly most diverse. The former is unquestionably a wonderfully rich agricultural country, while the agricultural efforts on the Laramie Plains are more recent and very much less extensive in their scope and variety, and the principal industry is ranching, the water being

used chiefly for raising hay, a use which throughout the world has been considered as beneficial and the basis of appropriation of water, and without which the prosperity of this industry of the State of Wyoming cannot continue. Two extreme views of the agricultural merit of the Laramie Plains are presented by the State Engineer of Colorado, Mr. Field, who in testifying in this case (p. 414) says: "When he (any investigator) observes the new irrigation projects he wonders whether the projectors have been competently advised, and whether it is not spoiling a good ranch country to make a poor farming country which is destined ultimately to failure. This impression I received when I first went in there, and it has been borne in upon me ever since, every time I go up there." In 1910, four years before he so testified, Mr. Field was employed as an irrigation engineer to investigate and report upon the Riverside Ranch, one of the larger ranches upon the Laramie Plains, then recently purchased by a company which planned to colonize it, and portions of his report are set forth in marginal pages 3624-3637; in this report he stated that the virgin soil yielded splendid crops; that rotation of crops should be practiced and much alfalfa raised, as a result of which he believed that two hundred sacks of potatoes per acre could be produced; that the land was worth for colonizing purposes from $35 to

$75 per acre, and that it should be divided into small tracts of 160 acres or more for sale to farmers who should farm the same in connection with the raising of live stock. It is doubtful if two hundred sacks of potatoes per acre could be produced ordinarily upon the Laramie Plains, but on the other hand we do not believe that the region is so worthless and unproductive as to make the use of water a waste instead of a proper utilization of the resources of nature. It may here be said that the agricultural character of the Wheatland tract, which is 2,000 feet lower, is not subjected to the same criticism on the part of the witnesses for Colorado, who concede that it is an agricultural district of real merit.

Amount of Water in the Laramie River.

A water supply investigation involves two elements—the amount of water in the stream, and the requirements of the land; and each is complicated.

The customary and best method to ascertain the amount of water flowing in a stream, and that used by the United States Geological Survey and by the hydrographers of the parties to this suit, is as follows: A suitable site is selected for a gauging station, and several measurements are made at different stream heights to ascertain, first, the cross section area of

the water at all heights, and secondly, the average velocity of the current at all heights. The channels of all streams and particularly of all mountain streams, are irregular and more or less shifting or changeable, and the accuracy of the chart showing the cross section area at different heights depends upon the number of cross section measurements which are made and the permanency of the conditions. To ascertain the velocity requires even greater care and detail, for the velocity not only increases with the height of the stream, but the velocities of different portions of the stream differ from the velocities of other portions at the same time, and in careful measurements it is necessary to determine the velocity of each portion by using a current meter at different depths at intervals of a foot or a few feet, clear across the stream. By the use of a formula which has been developed by hydrographers, these measurements as a whole are converted into an average velocity of the stream at a given height, and by securing such velocities for a number of heights a velocity curve can be plotted which in conjunction with the cross area chart establishes a curve determining the flow of water in cubic feet per second at the various stream heights. There is placed at this gauging station a gauge from which the height of the water may be determined. Sometimes an automatic register is used, sometimes a

staff gauge which must be read at regular intervals by an observer, and in some instances both are used to check against each other. By this means the flow of the river in cubic feet per second is ascertained, and this is easily convertible into acre feet per day, as one cubic foot per second is approximately two acre feet per day. It is obvious that the value of the stream flow record thus obtained depends upon the ability and accuracy of the hydrographer who establishes the rating curve, the number of measurements made by him at various heights and times, the accuracy of his current meter, the faithfulness and care of the daily observer who notes the gauge heights, and the accuracy of the automatic register.

The evidence on behalf of Wyoming was that the flow of the Laramie River at the Pioneer Dam at the upper or southern end of the Laramie Plains below all important tributaries of that river except the Little Laramie, was 207,000 acre feet in 1912 and 109,593 acre feet in 1913, and that the mean annual flow derived from the actual measurements for the twenty-four months from April 1, 1912, to March 31, 1914, was 161,054 acre feet; that the run-off of the Little Laramie River at the head of its valley and below all important tributaries from June 1 to December 31, 1912, was 93,667 acre feet, and for the entire year 1913, 59,637 acre feet. The conclusion of the

expert who testified on behalf of Wyoming, from a consideration of all hydrographic data over a period of more than 25 years, was that the mean annual flow of the Laramie River at the upper end of the Laramie Plains was approximately 200,000 acre feet. He further testified that this with the flow of the Little Laramie constituted practically the entire flow of the Laramie River and its tributaries above the Wheatland Reservoir No. 2.

The expert testifying on behalf of Colorado with respect to the run-off of the river reached the following conclusions:

Mean annual flow of Laramie River at Wood's Landing, a few miles above the Pioneer Dam	250,500
Sand Creek	17,000
Inflow between Wood's Landing and Pioneer Dam	14,400
Inflow from east side of Laramie Plains	12,800
Mean annual run-off of Little Laramie River	120,700
Four Mile, Seven Mile, Cooper and other creeks in northwest portion of area	12,800
TOTAL	428,200

The estimated run-off at Wood's Landing of 250,500 acre feet includes 20,000 acre feet, the mean annual diversion into the Poudre watershed through the Skyline and Divide ditches, which would pass Wood's Landing if not so diverted, and the aggregate amount of 428,200 acre feet is the estimated amount

tributary to the river system above the Wheatland Reservoir No. 2. A further amount of 20,000 acre feet is credited to Sybille and Blue Grass Creeks on the east side of the Black Hills, and large but unestimated flows are attributed to the North Laramie and Chugwater Creek, which enter the Laramie just above its mouth and below the irrigable area. Of the entire run-off he concludes that Colorado contributes 237,500 acre feet, exclusive of Sand Creek, of which amount 20,000 acre feet is already being diverted into the Poudre Valley through the Skyline and Divide ditches, and 56,000 acre feet, he concludes, will be diverted through the new tunnel, with a possible addition of 15,000 acre feet if the projected extension of the West Side Collection Ditch is made to McIntyre Creek.

The evidence relative to stream flow was given on behalf of Colorado by Mr. John E. Field, the State Engineer, and on behalf of Wyoming by Mr. Ralph I. Meeker, formerly hydrographer of the United States Geological Survey, who for two years had been employed by Wyoming appropriators to devote his efforts exclusively to gathering hydrographic data principally for the purpose of this suit. Mr. Field's testimony consisted of an analysis of stream flow records made by others, and his conclusions drawn therefrom, while Mr. Meeker's testimony was

confined almost entirely to records made by himself, covering a period of two years preceding the conclusion of the presentation of the evidence in May, 1914, but taking into consideration all other available data in existence.

In his testimony Mr. Field gathered together all available records, some made by the United States Geological Survey, some by the office of the State Engineer of Wyoming, some by the office of the State Engineer of Colorado, some by Professor L. G. Carpenter, some by Mr. Meeker. They covered in all about twenty-five years, but were in no sense complete, with the exception of the records for the last two or three years, the measurements having been intermittent and not consecutive throughout several years, and generally covering but a few months in any year. It is not surprising that Mr. Field found occasion to challenge, criticise and discard from his conclusions a great many of these reports, but strangely enough a peculiarly persistent coincidence led him to criticise and discard records which in almost every instance indicated a low flow, thereby affording an opportunity to substitute higher records, and rarely did he find occasion to criticise a measurement indicating a very large flow, excepting possibly to raise it. One record subjected to such criticism, and with respect to which considerable explanation was offered,

was that of the flow of the Laramie River at the state line in May and June, 1912. The record so criticised was that published by the State Engineer of Colorado from hydrographic data supplied by an hydrographer from that office and worked up in that office. But it appeared that during the extreme high water the river had overflowed its main channel and considerable volumes of water had passed through culverts under a road crossing the river at that point, and the hydrographer and the observer had never noted this fact. It was also true that the needle in the automatic gauge register operated imperfectly and for some time indicated a gauge height approximately one foot less than the true height as indicated on the staff gauge. The result of these conditions and imperfections was that the published record of the flow at that point was very much less than the true flow. Mr. Meeker, who, experienced and careful as he was, made errors in computation and cheerfully admitted and corrected them, presented what we believe is a fair criticism of the general character of Mr. Field's evidence as follows: (Marginal Page 4293)

> "The tendency throughout his hydrographic record is to consistently accept the records which give the greatest flow at stations where there were conflicts and to discard those records which would show a less discharge, thereby showing a larger amount of water in the Laramie River

basin available for irrigation on the Laramie Plains. A specific instance where he has used my records when they were higher than the Colorado records is at Wood's Landing where one of the year's records was too low and he had those records re-computed and revised, but he ignored another year of those records which, if revised according to the data available, would show a much less discharge than the face value of the records. I find no consistent reason why he should have adopted the method of taking the high years and destroying the low years, other than he had decided upon what volume of water was available in the Laramie River basin and made his computations fit the answer. A consistent and careful analysis of these records from a hydrographic standpoint does not permit of any such deductions, and it was because of the uncertainties and errors and unknown conditions under which the old records were secured that after an extended and careful re-computation of the old records at Wood's Landing and at other stations, I came to the conclusion that only in a general way could they be taken and not used concretely. They do, in a broad way, mark the yearly run-off if the winter flow records are disregarded and the two or three years which are grossly in error are disregarded."

But what we believe is the most remarkable feature of the testimony of this witness is his arbitrary use of an independent index likewise resulting almost invariably in an increase in the amount of water

claimed to flow in the river. As has been said, the records upon the Laramie were comparatively few and the earlier ones are concededly open to question. Therefore Mr. Field took the records of the flow of the Poudre River which had been kept continuously since 1884, and from them ascertained the mean annual flow of the river. Then calling this average one hundred per cent. he determined what percentage of the mean annual flow occurred in any particular year or in any combination of years. He then assumed that there was a relation between the river flow in the Laramie River and the flow in the Poudre, and that in any ten years, say, the mean flow would bear the same ratio to the mean flow for a thirty year period as the mean flow for those same years in the Poudre bore to the thirty year mean in that river. At the outset he disclaimed any contention that in any particular year there would be such a relation between the flow in the two rivers, and in fact the records which he accepted showed in numerous cases that the flow for a particular year in the Laramie bore a very different relation to what he in this remarkable manner determined to be the true mean over a long period, than the flow in that year bore to the mean flow of the Poudre, but he did seek to utilize this method of reasoning with respect to combinations of years as low as two in number, and in some in-

stances, despite his disclaimer, applied the same principle to a single year. Needless to say, by this method he developed a mean flow in the river considerably in excess of even that mean which he had ascertained from the Laramie River records alone after discarding the low records with which he was not satisfied.

We are unable, in a statement of facts, to present a more adequate idea of the basis of the evidence offered by Colorado relative to the flow of the Laramie River. Mr. Field's testimony commences on Marginal page 3387, and occupies a considerable portion of the balance of the abstract. His general conclusions, as above outlined, are set forth commencing marginal page 3473.

We could not compete with such an earnest builder of hypotheses; neither did we believe that a fair view of the practical situation could be derived from the consideration of stream flow records, made by men whose qualifications, care and diligence are unknown, working under unknown conditions with possibly imperfect equipment, and probably forced to construct rating curves applicable to very high flows upon pure guess-work. Accordingly our evidence relative to the supply of water in this drainage area has been confined to the testimony of a qualified hydrographer who actually installed the stations,

supervised the work and compiled the data, and his conclusions are strengthened and approved beyond the possibility of attack by the outstanding physical feature of the Laramie River irrigation development—the Wheatland No. 2 Reservoir. Mr. Meeker's final conclusions and records are set forth commencing with marginal page 4272, and there are found the several tables compiled by him covering the data which he had secured during the two preceding years. In Exhibit T7 (p. 4294) he shows the total flow in the Laramie River at Pioneer Dam, at the southern end of the Laramie Plains and below all Colorado tributaries excepting Sand Creek, to have been 207,000 acre feet in 1912, and 109,593 acre feet in 1913, and for the 25 months from April, 1912, to April, 1914, an average mean flow of 161,054 acre feet, and in Exhibit T8 he shows the total flow in the Little Laramie River at the point where it enters the Laramie Plains and including the amount diverted through a large upper canal to have been 93,667 acre feet, from June 1 to December 31, 1912, and 59,637 acre feet during the entire year 1913, and the mean annual flow as determined from measurements from June 1, 1912, to May 1, 1914, to have been 68,820 acre feet.

The very large discrepancy between the stream flow records presented by Mr. Field and those of Mr. Meeker is due in part to the methods of analysis

adopted by Mr. Field and his arbitrary use of the records of the Poudre as above explained. The remainder is due to his addition of arbitrary amounts as representing the accessions of the stream from miscellaneous sources after it enters the Laramie Plains. Of these supposed accessions Mr. Meeker testified as follows: (pp. 4304-4307)

> "Referring to Mr. Field's estimate of 12,800 acre feet probable run-off from mountain territory out of Four Mile, Seven Mile, Cooper and other small streams, heading in the mountains north of the Little Laramie River on the west side of the valley, the only run-off from that area is a very small inflow at times from Mill Creek to the Little Laramie. The most of this water is diverted before reaching the river, and applied on lands in that vicinity along the creek. Except Four Mile, I should say no water enters the Laramie River from those streams other than perhaps a small volume from Four Mile after very heavy torrential rains. The meadows along Four Mile require what little natural flow there is in the foothills, so practically no water reaches the Laramie River from that creek, as I have observed in crossing it. King's survey of the 40th parallel made in the 70's shows Cooper, Dutton, Four Mile and Seven Mile Creek as not extending to the Laramie River. Cooper, Dutton and Seven Mile enter depressions, but the other tributaries are not shown as continuous to the Laramie River, showing that at that date there was no inflow. Seven Mile flows into

James Lake, to which there was no outlet prior to the construction of the James Lake Irrigation System. Cooper and Dutton Creeks flow into Cooper Lake, having no connection with the river. There is practically no inflow from the source whence Mr. Field estimates 12,800 acre feet.

"Referring further to his testimony estimating an inflow of 12,800 acre feet from the mountain area on the east side of the Laramie Plains lying south of a point opposite Two Rivers, and a point opposite the Wheatland Reservoir, being an area of about sixty miles in length by five miles in width, very little water is contributed to the river from this area and that flows in from small tributaries south of Laramie such as Soldier, Willow and Five Mile Creeks, and then only in times immediately following heavy rainfall or perhaps a very small flow may reach the river during the melting of the snows in March. From that area lying north of Laramie, there is practically no inflow to the Laramie River from the area extending along the slopes of the Black Hills to the Wheatland Reservoir. On April 25th I made a special inspection trip of those channels or draws between the steel bridge at the Two-Bar shearing pens and Laramie and outside of a few small draws which may carry a little water after very heavy rains, and which enter the Laramie River a short distance above the steel bridge or immediately north of Laramie practically no water enters the Laramie River from the Black Hills. The slight flow or run-off from this area is intercepted by lakes and ponds

and is also intercepted by the Oasis and Boughton Ditches, and in turn carried to the lakes and ponds. The run-off in the Black Hills is very meagre, occurring only after torrential rains or the melting of snow in the early spring. In frequent trips to the Wheatland Reservoir during 1912, 1913 and 1914, I have never seen in the aggregate over a few second feet in any of the ordinarily dry channels crossing the road to McGill, and then only after heavy rains or in March or the first few days of April. Some of the water originating on the slopes of the Black Hills is absorbed in transit by the sedimentary formations at its base. Reference to the Laramie Quadrangle topographic map of the U. S. G. S. shows the intermittent nature of the drainage from the Black Hills of these channels and the termination of the flow near the base of the hills. Mr. Field's estimate of this inflow is much too great."

The estimated run-off of Sybille and its tributary Blue Grass Creek is likewise unimportant. These creeks are used to carry the water from the Laramie River to the canals of the Wheatland territory, and such water as they carry during the irrigation season is utilized, although frequently some water is turned back into Sybille Creek through the sand gates below the headgates of the canals, in the process of the usual flushing and cleaning operation. The watershed of Sybille Creek is subject to occasional cloudbursts,

but the water coming from such causes is a source of danger and not of supply, for the demand upon the canal system is so heavy and the supply from the ordinary flow of the creek so small that it is necessary to divert water from the Laramie River to the capacity of the distributing canals; as it requires several days for water to travel f om the storage reservoir upon the Laramie Plains to the canals, the Laramie River supply cannot be cut off and the cloudbursts utilized; and the flow from the cloudbursts superimposed upon the capacity flow from the Laramie River frequently washes out the headgates of the distributing canals. (Testimony of J. A. Elliott, pp. 164-167).

Neither do the North Laramie River and Chugwater Creek furnish a possible source of supply for irrigation of any of the lands now irrigated from the Laramie. Not only is each stream utilized to its capacity for the irrigation of lands in its watershed, but both lie below the Wheatland area and far below the Laramie Plains, and enter the main river a short distance above its mouth.

As has before been stated, Sand Creek is not in reality a tributary of the Laramie River. A large part of its supply is diverted into the Poudre Valley through the Divide Ditch and the balance is used along its course, so that only in unusual years does any part of its w 'er reach the river.

In common with Colorado we have taken into consideration the supply from the Little Laramie River for the purpose of ascertaining the total amount of water available in the main watershed, but the question at bar is, we believe, more narrow. The Little Laramie is entirely a Wyoming stream, and it, with the Laramie, constitutes one of the principal tributaries of the North Platte, which flows into Nebraska, a State which naturally asserts some rights to the benefit of the natural flow in that river. As the Little Laramie enters the Laramie above the Wheatland Reservoir, it is to some extent a source of supply for the Wheatland lands, and it has now been made one of the sources of supply for the recently constructed Lake Hattie Project upon the Big Laramie River. It does not, however, furnish any of the water for the irrigation of the lands heretofore irrigated from the Big Laramie River above its junction with the Little Laramie, and any surplus water therein would not be available to the farmers along the Big Laramie above Laramie City, if the water they have appropriated should be diverted into the Poudre. If the present question requires a consideration of all possible sources of supply for the lands now being irrigated upon the Laramie Plains and at Wheatland, and Colorado has the right to divert the water heretofore used in Wyoming and compel the Wyoming

appropriators to seek other sources of supply, the inquiry would lead much further, for as the defendants have so diligently shown, the Lake Hattie project includes a diversion from Douglas Creek, a tributary of the North Platte River, and we assume that other outside potential sources exist.

Adequacy of Water Supply.

But whatever the volume of water flowing in the Laramie River, the principal question of fact is the adequacy of that supply. It is the contention of Colorado that the flow of the Laramie River is ample not only for all Wyoming requirements, but for the Greeley-Poudre diversion. We have shown that as a matter of fact Wyoming has actually used all of the water for a period of twelve years, excepting in 1907 and 1909, for excepting in those years no water flowed past the Wheatland Reservoir at the lower end of the Laramie Plains, and this must be the most direct and conclusive answer to the contention of the defendants. Colorado insists, however, that there is great waste in the use of water in Wyoming, that the potential duty of water is much higher than the Wyoming practice would indicate, and that through the conservation of the surplus flow Wyoming would

have a sufficient supply after all existing and proposed diversions in Colorado are made.

This contention is largely based upon the conclusions of Colorado relative to the mean or average annual flow of the river, and the attention of its witnesses was directed almost exclusively to this aspect of the investigation. The mean annual flow is misdescribed as the "normal" flow, and it is assumed that this is the amount of water actually available in practice for irrigation purposes. The continuous thirty-year record of the flow of the Poudre River (p. 3394) well shows that the supposed normal flow is in reality abnormal. That record indicates a mean flow of the Poudre of approximately 317,000 acre feet, but this figure has no intimate connection with the amount of water really available for use under actual irrigation practice. In nine of the years preceding 1914 the flow fell short of this so-called normal by more than one hundred thousand acre feet, while in only four years was it more than one hundred thousand acre feet in excess of this mean. The mean is in fact largely attributable to a few years of extremely high flow which counterbalance a much greater number of years of smaller flow, and in consequence is 353,000 acre feet less than the highest year, while only 158,000 acre feet more than the lowest. Moreover, in 1884 the flow for only part of the year was more than one

hundred per cent. in excess of the annual mean, and the following year was fifty per cent. in excess. In the eight succeeding years the flow did not reach the mean, and the farmers whose crops burned up in 1893 and the three or four preceding years perhaps gained but little comfort from the statistical information that the so-called normal flow of the river was entirely adequate for their needs. Nothing approaching the record of 1884, within 200,000 acre feet, has been experienced in the thirty years since that time, and only four years have approached within 300,000 acre feet. Only seven years in the thirty have equalled one-half of the flow of 1884. For all practical purposes, therefore, the exceptional years of extremely high flow must be disregarded. A farmer cannot wait thirty years under terrestrial conditions for the one favorable year to raise the only crop of a lifetime. Indeed, even the years of moderate excess, which seem to run in cycles of ten or fifteen years instead of alternating approximately with the years of deficiency, mean very little in their practical effect upon the farmer's operations. If he could bear the immense expense of the storage works which would carry over the surplus for more than one or two years, the unstable substance would evaporate or seep away within that time and be lost irrecoverably in spite of his pains. What actually happens in such cases, even

in the celestial region of the Poudre Valley, is well illustrated by Mr. Armstrong's table (Exhibit 123, p. 2487) showing that out of the excessive flow of 448,000 acre feet in 1909 (p. 3394) 288,000 acre feet ran out of the Poudre into the South Platte, and that even in the "normal" year of 1912, 91,000 out of 319,000 acre feet were abandoned to the same fate. By what moral or legal right can the favored Colorado irrigator throw upon his Wyoming neighbor, already handicapped by an "arctic" climate, and an irresponsive soil, the burden of spending useless sums to conserve an imaginary or elusive surplus in the Laramie, which he so freely wastes in the Poudre—and this in order to seize the cheaper and more dependable supply already appropriated by the latter?

It is contended that this theoretical normal does establish the real stream supply because it may be conserved in reservoirs and the defendants apparently do indirectly seek to impose the duty of such conservation upon the Wyoming appropriators, in order that Colorado may take into another watershed the water which heretofore Wyoming appropriators have been using. Even in the Poudre Valley, the agricultural marvel of Colorado, in which its official witnesses boast that irrigation has reached a higher point than in any other part of the mountain states, experiencing for years an increasing pressure for water, with lands

so valuable that enormously expensive reservoirs are practicable, the reservoir development has not reached the point where the surplus floods could be stored. In the cross examination of Mr. Field (pp. 3721-3729) it developed that the total reservoir capacity in the Poudre Valley in 1912 was 146,655 acre feet, and at the conclusion of the irrigation season of that year 83,794 acre feet was in storage, being held over for use in 1913, leaving 62,871 acre feet of available capacity. As shown by the table of flow at page 3394 the total flow in the Poudre in that year was 319,353 acre feet, so that even at that late period in the development of the valley a flow of 382,224 acre feet would have furnished all of the requirements of the valley during the year and would have filled every reservoir. Any flow in excess of that figure, therefore, must be disregarded in determining the mean flow of the river for practical irrigation purposes, for any greater amount could not be conserved, and where two high years occur in succession as in 1884 and 1885, assuming that all reservoirs constructed in 1912 had then been in operation, not only would 288,000 acre feet have been lost to the Poudre Valley in 1884, but none of the high flow of 1885 could have been conserved, the reservoirs all being full. If an even larger amount of the flow of 1884-85 had been conserved it would certainly have been exhausted in 1888, which was

an extremely low year, and in the five succeeding years from 1889 to 1893 inclusive, in which the flow of the river fell far below the average, the farmers would have received no aid even from a very extensive reservoir system. Again we find that in the nine years from 1899 to 1907 inclusive, the flow exceeded the average by a very large amount, with the exception of two years, and these cumulative floods could not be conserved for subsequent use.

Thus it is seen that even in the Poudre Valley, where irrigation development has reached its highest point, it is now impracticable to construct reservoirs so as to make the supply actually available in practice equal to the mean flow of the river.

Even more true is this of the Laramie Plains. The witnesses for Colorado have described in detail the agricultural imperfections of this area, and have concluded that the expenditure of money for irrigation works even of an inexpensive kind, is a waste. To this region Colorado would apply an irrigation practice for which the Poudre Valley is not yet ready, and would compel those who it is said are unable to raise remunerative crops to expend large sums and to conserve from year to year, and possibly for several years, the large floods frequently superimposed upon each other, even such floods as that of 1909, which for six weeks poured in a torrent from the hurriedly

constructed spillway of the Wheatland Reservoir.

The following is the view of Professor Carpenter, Colorado's principal exponent of the complete utilization of water supply (pp. 3936-49):

> "With regard to financial practicability of construction of reservoirs on Poudre River capable of conserving extraordinary floods, will state that they call for an expenditure that could be utilized only occasionally. It would be similar to financial proposition of people in Florida preparing to heat their houses in the same manner as those in the northern part of the United States. For years of unusually high flow in the Poudre River, conservation works, to utilize the excess waters in that stream, would have to count on carrying water over more than one year. The utilization of this water means the presence of population on the land; *that population must have a living from year to year* and they are not justified in going out on to the land and settling to raise a crop only once in three or four years. They must have sufficient to make a living from one year to another, and consequently the investment must be such that there can be sufficient water every year to keep these people on the land, and when water can only be conserved once in every three to five years, there must be provision for carrying over water or the people cannot live. It is a question of population as well as investment. The population has to exist and stay on the ground. From standpoint of investment, conservation of flow such as extreme flow of 1884 would be impractical to the extent that it exceeded

the ordinary high year. Of such character would be the floods of 1885, 1900 and 1909, three years in thirty."

Not only would such reservoir construction be impracticable, but it would be futile, for as emphasized by the witnesses for the defendants, the evaporation upon the Laramie Plains is very rapid, being perhaps as much as six feet per annum, and it may easily be computed how much of the water stored in 1909 in a reservoir even as much as thirty feet deep would remain for use even three years later.

The agricultural and industrial development of the Laramie Plains which the State of Wyoming now seeks to protect, came from the utilization of the natural flow of this stream through direct diversion. Prior to 1908 practically no reservoirs had been constructed for the conservation of water for use upon those lands. The principal and almost the only use has been for raising hay, the one great necessity of that stock-growing region, and the witnesses for the defendants insist that this is the only use which can be made of the water with any profit. Wyoming does not believe that Colorado, which has fully utilized so far as its territory will permit, all of the water of that river within its own valley, may now divert a large part of its flow into another watershed, and impose upon these prior appropriators in Wyoming

the expense of a reservoir development which Colorado itself has not attained, which would be prohibitive in cost and which would be largely futile.

Time of Use.

The time in the year when water must be used upon the lands on the Laramie Plains presents in a narrower form the same question as the contention of Colorado that the average water supply over a long period of years must be the basis of determining the adequacy of the supply. The defendants insist that because it is possible to construct reservoirs to conserve water from one year to another, the average flow of the stream is the decisive factor, a deficiency in any year being made up by water drawn from these reservoirs. Likewise they ask us to view a whole year as an entirety, and consider the flow throughout the year without reference to its distribution, but this view likewise depends upon the assumption that reservoirs can be constructed, that the expense of such construction would be justified by the returns from the use of water, and that the Wyoming appropriators can be subjected to such expense in order that Colorado may divert the large amount it proposes to take into the watershed of the Poudre. But the Wyoming appropriators do not have such reservoirs and their appropriations, far prior in point of time to the con-

templated diversion in Colorado, are from the natural flow of the stream, and just as the historical existence of a large flow three or four or six years before cannot diminish the loss of the farmer who in any year of comparatively low flow is unable to raise feed for his cattle by reason of the Colorado diversions, so these old appropriators cannot, in July and August, be solaced by the thought that in May and the first two or three weeks of June there had been an abundant supply. May and June are ordinarily the months of the greatest rainfall. They likewise are the first warm months following the winter, when the grass is deriving growth from the moisture stored in the ground from the winter snows. July and August are the warmer months with less rainfall, with no moisture conserved from winter, and consequently the months of the greatest need for water. The flow of the stream, however, comes in May and June, and in the latter part of June and during July and August when the need is greatest the flow is smallest. Furthermore the high mountain area at the head of the Laramie River contributes a proportionately larger amount to the river in the latter part of the season than during the months of May and June.

Defendants' Exhibit 125 (p. 3418) gives the discharge of the Laramie River at its highest gauging station, Glendevey, a short distance below the Greeley-

Poudre tunnel, and covering parts of six years. The months from September to March inclusive furnish but very little water; in April the run-off was about doubled over that of March, and in that month the average run-off was a little less than four per cent. of the annual flow. In May, during the latter part of which the mountain snows begin to melt, twenty per cent. of the annual run-off occurred, and this was doubled to more than forty per cent. in June. July had more than thirteen per cent. and August a little less than four and one-half per cent. The records at this station do not take into account the water diverted into the Poudre watershed by the Skyline and Divide ditches, the mean annual amount of these diversions, according to the note attached to the exhibit, being a little over 20,000 acre feet; these diversions commence in June and continue until about October, and are proportionately greater in July and August as compared to the total flow of the stream, than in June, so that if these amounts were added to the records at Glendevey the percentage of the total run-off of the stream from April until August inclusive would be almost ninety per cent. of the annual discharge, and the percentage of the discharge in July and August would be likewise increased.

Defendants' Exhibit 128 (p. 3440) shows the discharge of the Laramie River for fifteen years at

Wood's Landing at the head of the Laramie Plains, with an average annual flow of 254,111 acre feet. It will be observed that the winter flow is proportionately greater than at Glendevey, higher in the mountains, and is larger in the first few months of the year than during the first months of the winter, a fact which led both Mr. Field and Mr. Meeker to question and discard the winter records. By this table it is shown that the average monthly discharge increases from four per cent. in April to twenty-three per cent. in May and to thirty per cent. in June, in which month the average discharge was 76,107 acre feet. This falls to 22,293 acre feet in July, and 7460 acre feet in August, the July flow being less than nine per cent. and the August flow less than three per cent. of the annual flow as compared to thirteen per cent. and four and a half per cent. respectively in the same months at Glendevey, indicating that the percentage of the discharge in the higher areas in July and August is fifty per cent. greater than the discharge of the entire watershed. The discharge at Glendevey in May is only twenty-three per cent. of the discharge of the river at Wood's Landing, but the discharge in July is forty-five per cent. of the discharge at Wood's Landing, and the discharge in August is more than forty per cent. of the Wood's Landing flow. This condition would be further aggravated if the diversions

through the Skyline and Divide ditches were taken into consideration, and it is probable that the discharge at Glendevey in July and August including those diversions amounts to more than one-half of the entire water supply of the Laramie River.

The witnesses for Colorado testified that not more than seventy-five per cent. of the water intercepted by the Greeley Poudre collection ditches can be diverted into the Poudre on account of the condition of the ditches and the impossibility of catching all of the water, but they further say that during periods of pressure such as in years of very low flow or during July, August and September of each year, a relatively greater amount of water can and will be taken. If the amount diverted is only eighty per cent. of the flow intercepted by these ditches, it will mean a loss to the farmers in Wyoming of more than forty per cent. of the entire available supply during these months of greatest need.

Referring to the conclusion of the State Engineer of Colorado (p. 3626) that the greatest demand for water upon lands on the Laramie Plains is in July, when three-fourths of an acre foot per acre will be required, even his excessive estimate of 22,293 acre feet discharge at Wood's Landing in July would furnish water for only 30,000 acres of land, and of this Colorado threatens to divert more than 9,000 acre feet.

Methods of Use.

As a part of the investigation of the adequacy of the water supply, Colorado contends that there is great waste in the use of water in Wyoming, this complaint being directed against the appropriators upon the Laramie Plains. Much evidence was offered with respect to the "duty of water", a term upon the definition of which no two experts seemed to agree, but which may be described as determining the amount of land which may properly be irrigated from a given quantity of water. Necessarily the duty of water must differ as conditions differ. Not only is it affected by the rainfall, the humidity and temperature and the length of the season, but it varies with the crop, the soil, and the method of use, and the method of use must necessarily depend largely upon the character and value of the crop. The experimental plot, watered carefully from the sprinkling can, may be brought to maturity with much less water than the open field, irrigated from laterals, and the careful conservation of water in the orange groves of California will develop a much higher duty of water than the distribution from open ditches upon the beet fields of the Poudre Valley, just as such use in the Poudre may develop a higher duty of water than the irrigation of hay meadows by flooding them.

Upon the Laramie Plains the practice in the irri-

gation of the hay meadows is to spread the water over the land from occasional laterals, flooding the land for several days at a time. Possibly as compared to the method of irrigation of cultivated crops worth one hundred or five hundred dollars per acre, this method may seem wasteful. Taking into consideration the crop raised, however, it is the only possible method, and is the method which of necessity has been used throughout Colorado and in every other mountain State. The crop is not a sowed or cultivated crop and the water cannot be conducted through furrows. It cannot, in the nature of things, be applied otherwise than in a sheet spread over the surface and percolating downward into the turf, which does not absorb water as readily or quickly as tilled soils. Though the amount applied is large, the actual consumption is relatively small, and this method is not so wasteful as might be supposed. The longest of the old canals upon the Laramie Plains was the Pioneer Canal, irrigating in 1913 less than 12,000 acres, and covering land not more than five or six miles from the river. All of the other canals are short, irrigate but a few hundred or at the most a few thousand acres, and the lands irrigated lie within a mile or two of the river. From the meadows irrigated in the manner described, the water returns very rapidly to the river channel and there is not even much seep-

age, the return flow being largely from the surface. The method of use in the Laramie Valley in Colorado is identical, but the appropriators are even more generous in the application of water. The practice in that region is shown by Mr. Field in his report made in 1910 upon the Riverside Ranch, wherein he said (p. 3625):

> "A number of the Colorado canals take water from tributaries of the main stream and the diversion by them is probably much less than is indicated by the published statement of decrees. This less diversion is also probable from the fact that decrees in Colorado are almost always excessive and many have never been used at all. The capacity of all canals reported on by the Water Commissioner of District Number 48 is given as 563 cubic feet per second, while the irrigable area is given as 4,720 acres, using 57,894 acre feet, or nearly 12 acre feet per acre per annum, an amount obviously wasteful and excessive."

In the same report (p. 3626) he expressed his opinion relative to the methods of use, the water requirements, and the waste upon the Riverside and Hoge ranches upon the Laramie Plains, as follows:

> "On the Riverside and Hoge farms the duty of water should not be very low, as on the meadows during the high water period, that is, in May and June, there will be a certain amount of sub-irrigation and overflow. The greatest demand will

probably come in July, during which month probably three-fourths of an acre foot per acre will be required, or one cubic foot per second will probably serve about eighty-three acres. The decrees of the Company call for one cubic foot per second for each seventy acres.

"The canals serving the land are comparatively short, and the losses proportionately small, and even that which is lost by seepage in transit will be of benefit to the land under which it passes on its way to the river.

"In August and September little water will be used, as most of the crops will have been harvested and even the late maturing crops will have begun to ripen and the water will have been taken off of such crops. In all two and one-half acre feet per annum per acre is doubtless an ample supply, and the decrees owned by the Company and the water available in the river will furnish that amount."

Even more interesting is the testimony of John L. Armstrong, who had been Water Commissioner upon the Poudre River for twenty-four years, and is justly credited in Colorado with being a remarkably efficient and able administrator of water distribution. He was encouraged to describe in detail his remarkable efforts to prevent the waste of water; how he made secret trips at night to headgates to prevent surreptitious diversions, and how he used the devious tactics of a fugitive from justice to prevent water users from knowing his whereabouts, so that he might drop upon

them unawares. Upon his cross examination (pp. 2515-16) he stated the amount of water used in 1909 and 1910 through a large number of Poudre Valley ditches, each with an appropriation in excess of 25 second feet, an amount supposed to be sufficient in Colorado for the irrigation of at least 2,000 acres of land, and it appeared that these ditches used as little as .59 acre feet per acre to as much as 7.94 acre feet per acre, a number of them using more than 3 acre feet per acre. As these amounts exceeded so greatly the duty of water in that valley as testified to by him and other witnesses, the defendants pursued the inquiry much further upon re-direct examination, and thereupon Mr. Armstrong said:

> "The B. H. Eaton Ditch has old decree and irrigates bottom land. It has excessive appropriation and appropriates all water that it has use for. They generally take all they care to run. I do not remember having shut the headgates of either of these canals during my life. It don't make any difference to me how much or how little they take. If they take more than they can use the surplus goes right back into the river and is available for other ditches below. There could be no actual waste in that regard." (p. 2522)

> "Ditches diverting water and applying it along banks of Cache la Poudre River, occurring between mouth of canal and diversion by Ogilvie

Ditch and which I used for irrigation of bottom lands, are Dry Creek Ditch, Whitney Ditch, B. H. Eaton Ditch, J. G. Coy Ditch, Josh Ames Ditch, Bristol No. 1 and No. 2 from Box Elder Creek, Burnham and Emerson Ditch from Long Pine Creek. Very little difference is made in flow of stream by allowing diversions to these canals, because if they take more water than they need on the land, it returns immediately to the stream and we get a great deal of that which they use. There are other small ditches taking water from branches of the Cache la Poudre River and noted on this table. Conditions are practically the same with relation to these.

"None of the ditches I have named are in any way to be compared with the larger canals such as Larimer County, Larimer and Weld, Greeley No. 2 and North Poudre system. The decrees of those smaller ditches are always excessive, more than they can possibly use. They are always entitled to water; whether they take more than they are entitled to or not is immaterial. For example, the John G. Coy Ditch has never been considered by me in carrying water down past the Larimer and Weld Canal. I regulate river at Larimer and Weld Canal to supply what I know is needed for larger ditches below that go out to irrigate land on plains. But in sending down amount required, I do not consider whether John G. Coy Ditch is irrigating or not. It makes no practical difference, and even if they are using water, the bulk of what they use goes back into river anyway and is available below for other ditches." (p. 2526-27)

"I presume the Poudre Valley prides itself on having the most efficient administration of the distribution of water and the most economical use of it of any part of the mountain region. I have very little knowledge as to the method of administration of use in other parts of the State, however.

"The smaller ditches in District No. 3 are mostly old ditches in the river bottom and having early priorities so that it is not necessary to give a great deal of supervision to their use of water. In my opinion it is not a matter of much difference whether they take more water than they have an absolute need for or not, for the water will return to the stream very quickly. This return is not only through the water flowing from the end of the ditch to the stream, but through the water which has been spread over the land seeping back to the river." (p. 2536)

"Among the ditches with early priorities and which do not materially affect the irrigation from the stream on account of seepage returned is the Dry Creek Ditch, irrigating about 2,300 acres. It is about 4½ miles long and carries water more than a mile distant from the river. Another such ditch is the Whitney Ditch which irrigates 3,500 acres, is four or five miles long, and the land irrigated may extend for a mile from the river. With a lateral at the end of the ditch it may be 7 miles long." (p. 2538)

Upon this same general subject Mr. Meeker testified as follows (pp. 4317-21):

"From my records and experience, the duty of water diverted from the Laramie River between the Pioneer Dam and Two Rivers Stations is approximately one acre foot per acre. This includes copious flooding of the meadow lands and irrigation of the pasture land adjacent to the river. If all the lands irrigated between these stations were included, the duty of water would be higher. I am familiar with the method of diverting, carrying and applying water in the Laramie Plains and also in Colorado. The irrigation on the bench lands of the Laramie Plains is very similar to the irrigation generally in Colorado, notably on the Gunnison, the South Platte and the North Platte Rivers, and the Arkansas, and other streams where native hay is raised in large quantities. I am familiar with the character of the diversion dams, headgates and other similar irrigation works in the Poudre Valley in Colorado, and those on the Laramie Plains, with the exception of some very small dams. The works on the Laramie Plains compare very favorably with those in the Poudre Valley in efficiency and with respect to waste of water, and those ditches which have temporary dams usually only require those for the late meadow irrigation or otherwise the dams would be more permanent in character. The temporary character of the dams does not result in a waste of water because there are large numbers of ditches below that have prior requirements to which water must be passed. Taking into consideration the entire system of ditches and reservoirs on the Laramie Plains and especially the

location and character of the Wheatland Reservoir No. 2, the net loss or waste of water resulting is no greater than in other irrigated areas generally and for the reason that the Wheatland Reservoir No. 2, which is a channel reservoir and has a large priority over many of the ditches above receives all the return flow of the river and its tributaries above that point and uses it, making it available for use on the Wheatland lands below, there being no corresponding condition in Poudre Valley, where water is more likely to be lost than in the Laramie Valley. The return flow from the irrigated lands along the Laramie River is very rapid."

The evidence in the case as above outlined clearly shows that the methods of use upon the Laramie Plains are identical with the methods of irrigation under similar circumstances in Colorado and other districts, and that it is not only the only practicable method applicable to irrigation for hay, the only crop which Colorado thinks can be raised upon the Laramie Plains, but is not in reality wasteful, the return of the surplus water to the river channel being rapid and proportionately large in volume. The strategic position of the Wheatland reservoir at the lower end of the Laramie Plains makes the methods of use in that district unusually efficient, for that channel reservoir catches and conserves the entire return flow, all seepage and all miscellaneous accessions of the

river. Theoretical testimony with respect to an ideal duty of water and the requirements of irrigation must yield to the fact; the entire flow of the river has for many years been utilized in Wyoming under a system which Colorado's greatest practical expert designates as non-wasteful. Surely we need not consider the difficult question of the probable amount of water necessary for the irrigation of a single acre, nor seek to arrive at an exact determination of the number of acres of land irrigated nor the number of acre feet of water flowing in the stream; we have shown that the actual requirements of the entire area call for the use of the entire flow of the stream.

In connection with its evidence relative to the waste of water upon the Laramie Plains, Colorado offered the testimony of its engineers, George P. Woodhall and John E. Field, concerning numerous ponds and lakes of waste water and saturated areas of waste lands. Mr. Woodhall (pp. 2741-50) mentioned in a general way a large number of such ponds without attempting to give the acreage of all of them. Mr. Field, however (p. 3569), stated that the area of such ponds and lakes as he had been able to tabulate aggregated over 6,000 acres, and that altogether there was probably as much as 10,000 acres of such water surface, the annual evaporation from which he estimated to be as much as six feet (p. 3754), but

fixed conservatively at five feet (p. 3575) making the total evaporation from these waste bodies of water as much as 30,000 acre feet per annum. He further estimated the acreage of the waste wet areas at 10,000 acres, from which he estimated an evaporation of another 30,000 acre feet per annum (p. 3575, p. 3641). He was unable to point out the location of such saturated areas, excepting that the principal one was a strip of land extending along both sides of the Pioneer Canal for about fifteen miles (p. 3754). The total annual evaporation from these waste lakes and saturated areas was thus ascertained to be about 60,000 acre feet, or more than the amount which the witnesses for Colorado testify can now be diverted through the Greeley-Poudre tunnel.

The natural inference from the testimony of Mr. Field and Mr. Woodhall relative to these waste ponds and lakes was that they were the result of an excessive and wasteful use of water and represented diversions from the Laramie River very largely in excess of the amount necessary for the irrigation of the land. Upon cross examination, however, Mr. Field produced a schedule of these lakes and ponds (p. 3644) aggregating 6379 acres, of which 3200 acres constituted Cooper Lake, a natural lake in the northwest part of the Laramie Plains region fed by Cooper and Dutton Creeks, and, as stated by Mr. Field, never a tributary

of the Laramie River. No part of this lake was due to the diversion of water from the Laramie River or from any other stream, but on the contrary, whatever irrigation development had taken place along Cooper and Dutton Creeks had to that degree affected the supply of this natural lake. Likewise 147 acres lay in Creighton Lake and 392 acres in Hutton Lake, connected with Creighton Lake, both of which are natural lakes with a water supply from Antelope and Sand Creeks, and both of which had been turned into reservoirs.

After Mr. Field had so testified, Mr. Meeker, on behalf of Wyoming, made a reconnaissance of the sections of the Laramie Plains which Mr. Field asserted were saturated waste land, and for the purpose of illustrating the inevitable occurrence of ponds and seeped areas even under the best irrigation practice, he made an examination of about one-third of the irrigated area of the Poudre Valley, and he testified as follows with respect to the situation in both districts:

> "I heard the testimony given by John E. Field, at Denver in relation to waste of water on Laramie Plains and recall roughly his testimony on that subject, applying to the area lying along the Pioneer Canal from a point south of Lake Hattie Reservoir to a point near Fraser's Ranch, taking in also the area in the neighborhood of

the Soda Lakes, and the area to the north of the Pioneer Canal as well as to the south. Since this testimony, I have examined anew this section of country with this testimony especially in view. I was also over that neighborhood at different times in 1912, 1913 and 1914 and became reasonably familiar with it. A recent examination of this area shows 261 acres of seeped waste land. That land is pretty well saturated with water and has alkali on it, produced no plant of value for stock feeding; should be classed as thoroughly waste; of the general character described by Mr. Field, except that he went a little further and said that it was practically barren. It supports alkali weeds and very small vegetation of no value.

"I also heard Mr. Field's testimony in regard to similar areas in the vicinity of the Bath and Alsop Lakes and the Little Laramie Valley, and have since made a particular examination of that region. Excluding land in the big basin not now covered but later in the season covered with water, I would say that in the vicinity of the Bath and Alsop ranches and through that portion of the country there is not to exceed 50 acres of seeped waste land. This region was examined on the 18th of May and the area under the Pioneer Canal on April 16th. Since Mr. Field's testimony, I have made a trip through the Poudre Valley in Colorado on April 20, 21, 22 and 23 by automobile for the purpose of examining the areas of seeped waste land and water surfaces, etc. I took note and platted on topographic sheets the larger areas encountered

of seeped waste lands, amounting to 1441 acres. I covered approximately 100,000 acres, about one-third of the irrigated lands in that valley. The seeped areas are very similar to those found on the Laramie Plains."

This testimony is generally corroborated by Mr. Sevison, who accompanied Mr. Meeker. (pp. 4203-4207).

With respect to the discrepancy between the testimony of the witnesses for the respective parties concerning the area of land under irrigation upon the Laramie Plains we have said that it is probably explained in large part by the obvious difficulty of a stranger in determining the limits of the lands upon which water is turned for the purpose of increasing the growth of native grasses; the discrepancy is further accounted for by the difference in the conclusions of witnesses as to the character of the land as just illustrated, for it is apparent that the unfavorable observers who made examination on behalf of the defendants concluded that land upon which comparatively little water had been used had not been irrigated, but where the land was thoroughly saturated by very recent irrigation they determined that it was a waste area.

Extension of Irrigation.

The record develops one other important element

of this case, the future irrigation development of this district. It is shown that irrigation development is always gradual and cannot be forced; that in Colorado, water rights are adjudicated for a definite amount of water, and as the owner of the right brings his lands under cultivation, fills up the subsoil, and establishes economies in the use of water he extends the use of that given quantity over additional areas or sells or rents to other land owners some portion of the water right, and so from year to year the area reclaimed expands and the ditch is extended from one piece to another, all without loss of priority. This method of development is discussed by Professor Carpenter, the Colorado expert, on pages 2314-2316. He states that in 1870 the Poudre River supplied water for the irrigation of about 10,000 acres, in 1880 perhaps 40,000 acres, in 1890 about 130,000 acres, and in 1913, 260,000 acres, and that the struggle between appropriators is much less now than twenty-five years ago. He explained how the land gradually became saturated and the water level raised, lessening the requirements of that particular land so that the same amount of water could be used over an enlarged area. Such likewise is the history of irrigation upon the Laramie River in Wyoming, although the process has necessarily been much slower, and the courts of Wyoming have recognized, as have the courts of all

other States, the right of the appropriator to take the necessary time for the complete reclamation of all of his land. In the Wheatland tract there are 57,000 acres, of which 33,000 acres are now under cultivation. At the time the testimony was taken only ten per cent. of the 10,000 acres in the Bordeaux tract had been reclaimed, and no irrigation had yet taken place upon the Sybille tract, both of these being natural extensions of the Wheatland system. The same is true upon the Laramie Plains, Mr. Field testifying (p. 3638) that but fifty per cent. of the land lying under the old constructed ditches was under irrigation in 1913, and in addition there were tens of thousands of acres of new land under the ditches of the Lake Hattie and James Lake projects.

The James Lake project derives its principal supply from the Little Laramie River, and covers 30,000 acres. The original surveys for the project were commenced on March 22, 1908, (p. 638) and the construction work upon the James Lake Reservoir, with a capacity of more than 40,000 acre feet, upon the outlet Canal, the North Canal, one of the main distributing canals thirty-two miles in length, and the South Canal, nine miles in length, in the same year, and all were completed by July, 1909 (p. 633). The supply ditch leading into the reservoir was completed to a point where it could be used in 1909, and finished in 1911.

The Lake Hattie project is larger, planned to cover 60,000 acres of land outside the original irrigated area (p. 649) but finally constructed to cover 43,100 acres under its North Canal, now completed, 37,760 acres under the Stewart Canal, substantially completed, and 31,360 acres under the High Line Canal, upon which work had not commenced in 1914. (p. 781). In view of the contention of Colorado that the Greeley-Poudre system is entitled to assert a priority of appropriation relating to the time of the vision of Wallis Link, despite the many years which passed before any real work was performed, it is interesting to note that the Lake Hattie system was constructed by the owners of the Pioneer Canal, and that their predecessors had had surveys made from time to time commencing in 1886, for a canal substantially identical in location with the Pioneer High Line Canal. In 1886 Loback and Bellamy made a reconnaissance of this line and in 1887 Loback ran a survey of it (p. 751). In 1893 Bellamy made a preliminary survey and commenced to set stakes for final location when the panic of that year stopped the work, but not before the company had put in a flume upon the Pioneer Canal large enough to carry the water of that canal and also the water of the proposed High Line. (p. 770-71). In 1897 and 1898 Roach and Owen again surveyed the line, but the company could not

finance the construction, and in August, 1906, Roach also surveyed a line of canal corresponding with the subsequently constructed North Canal of the Lake Hattie system. When Sevison made a survey preliminary to actual construction of the High Line Canal in 1908 he found the stakes of one of these old surveys and followed the line so marked very closely. These stakes, from their condition, he judged to be at least ten years old (p. 660). Finally, on April 16, 1908, new surveys were commenced which continued for more than a year, and the preliminary work having been accomplished, the definite location survey was commenced on May 1, 1909, the construction contract let on June 14, 1909, and actual construction begun on July 11, 1909 (p. 646). By July, 1910, the work of enlarging the Pioneer Canal from the capacity of 300 second feet to the capacity of 1200 second feet had been completed, Supply Canal No. 1 into Lake Hattie Reservoir was completed to within 2000 feet of its end, and earth-work of the dam completed, the North Canal finished to a point opposite Laramie City, the South Canal completed to a point where it was intended to cross the river (p. 648), and prior to December 1, 1910, $944,000.00 had been actually expended upon the system. The principal units of the system were in operation early in 1912, and in that year a large quantity of water was stored

in the reservoir, and in 1913 water was carried through the North Canal, the principal distributing canal, and land irrigated from it. At the time testimony with reference to this work was taken in October, 1913, $1,418,000.00 had been expended thereon.

It is not our purpose here to discuss any fine and close questions of technical priority between individual ditches, but to note that final surveys were made for these two new projects while only desultory work was being performed upon the Poudre River diversion works of the Colorado scheme; that the James Lake project was devised, surveyed and practically completed before the final plans of the Greeley-Poudre project were made, and before the contract had been made for the construction of the system; and that the preliminary and final surveys were completed, work actually commenced with diligence and with the expenditure of large sums upon the Lake Hattie system before the Greeley-Poudre construction contract was made in September, 1909.

And so the State of Wyoming, through its citizens, has been following the practice of all individual appropriators, has constructed and put in operation irrigation works covering vast areas, has already irrigated a portion of these lands, finding the use of all of the water in the stream necessary for that purpose, and as economies in the use of water are possible and

the development of the country justifies, it is extending the irrigated acreage. It has recognized as between its citizens this right to extend the use of water without loss of priority, and by the decrees of its courts, which have been offered in evidence, has adjudicated water rights prior in point of time to the year 1900 for more than 200,000 acres of land to be irrigated from the Laramie River, more than 48,000 acres to be irrigated from the Little Laramie River, more than 3,000 acres to be irrigated from Sand Creek, 2,000 acres to be irrigated from Willow Creek, 6,000 acres to be irrigated from Sybille Creek, and 3,700 acres to be irrigated from the North Laramie River. In the 200,000 acres for which water rights from the Laramie River under ditches constructed prior to 1900 were adjudicated, there are some duplications, but the net amount is in excess of 180,000 acres. The total of these adjudicated rights is more than 240,000 acres, and in addition are the 100,000 acres of land in the Lake Hattie system, the 30,000 acres in the James Lake system, and the 30,000 acres in the Sybille and Bordeaux units of the Wheatland district, a total of 400,000 acres now being irrigated and proposed to be irrigated in Wyoming under ditches far older than or at least contemporaneous with the Greeley-Poudre project. For all of this land being gradually brought to an increased state of productivity through the use of

Nor are defendants in better case under the rule of equitable distribution of the waters. This rule of equitable distribution is an administrative application of the doctrine of riparian rights and confines itself to lands within the watershed.

It would not be equitable distribution to permit the Poudre Valley to use the large flow of the Poudre, and then add waters from the Grand, and then add waters from the Michigan, and then add the waters heretofore taken from the Laramie, and now still further take from the Laramie for use in the Poudre Valley the further large quantity of water here threatened to be taken.

2. The General Doctrine of Prior Appropriation.

Whether this court shall deem it necessary here to adopt the doctrine of riparian rights or the doctrine of prior appropriation, the issues and the evidence furnish the means to deal out equity between the parties.

As is proper, in order that the court may have before it the entire situation the record as we have seen discloses the facts necessary for the determination of the rights of the parties under the riparian rights doctrine.

In like manner the record discloses the necessary

facts for applying the doctrine of prior appropriation. And among these facts the plaintiff alleges on the one side, and the defendants admit on the other, that in the region in controversy, "in accordance with the customs and usages of the people, recognized by the laws and decisions of the Courts of both Colorado and Wyoming, in all cases where prior rights to the contrary have not intervened it has been the custom to divert and apply the waters of the natural streams to supply the deficiency in the annual precipitation to cultivate the lands within the drainage basin of said streams and make the same productive. Under the said customs, usages, laws and decisions it has been established, enacted, held and decided in both States as to the waters of all streams and other sources of water supply where prior rights to the contrary have not intervened that such waters are open for a reasonable appropriation and use for irrigation purposes; that except as aforesaid priority of appropriation gives priority of right."

It may not be amiss, besides, to make brief reference to some of the declarations of the people and courts of Colorado, Wyoming and other States upon the question.

The Constitution of Colorado, Article XVI., Sections 5 and 6, contains this language:

"SEC. 5. The water of every natural stream, not heretofore appropriated, within the State of Colorado, is hereby declared to be the property of the public, and the same is dedicated to the use of the people of the State, subject to appropriation as hereinafter provided."

"SEC. 6. The right to divert unappropriated waters of any natural stream to beneficial uses shall never be denied. Priority of appropriation shall give the better right as between those using the water for the same purpose; but when the waters of any natural stream are not sufficient for the service of all those desiring the use of the same, those using the water for domestic purposes shall have the preference over those claiming for any other purpose, and those using the water for agricultural purposes shall have preference over those using the same for manufacturing purposes."

Many Colorado cases state and illustrate the same doctrine.

Coffin v. Left Hand Ditch Co., 6 Colo. 443.
Hammond v. Rose, 11 Colo. 524.
Schilling v. Rominger, 4 Colo. 100.
Wyatt v. Larimer etc. Irrigation Co., 1 Colo. App. 480.
Beaver Brook Reservoir Co. v. St. Vrain Reservoir Co., 6 Colo. App. 130.

The Constitution of Wyoming, Article VIII., Sections 1 and 3, are as follows:

"SECTION 1. The water of all natural streams, springs, lakes or other collections of still water,

within the boundaries of the State, are hereby declared to be the property of the State."

"SEC. 3. Priority of appropriation for beneficial uses shall give the better right. No appropriation shall be denied except when such denial is demanded by the public interests."

The decisions in Wyoming further illustrate the same matter.

Farm Investment Co. v. Carpenter, 9 Wyo. 110.
Willey v. Decker, 11 Wyo. 496.

Similar decisions occur throughout the arid region.

Atchison v. Peterson, 1 Mont. 561.
Crane v. Winsor, 2 Utah 248.
Jones v. Adams, 19 Nev. 78.
Barnes v. Sabron, 10 Nev. 217.
Irwin v. Phillips, 5 Cal. 140.
Kidd v. Laird, 15 Cal. 161.
Sharp v. Hoffman, 79 Cal. 404.

3. In Colorado and Wyoming Simple Doctrine of Prior Appropriation Existed Prior to Their Constitutions.

The view and principle as adopted by the constitutions and statutes of Wyoming and of Colorado, and the customs of the people in these two States as disclosed and announced in the decisions of the courts in both States, reject the common law doctrine of riparian rights, and substitute instead the principle

that any and all unappropriated waters may be appropriated, and that, as stated in the constitution of both States, priority of appropriation shall give the better right. Indeed it is held in both States that this principle existed as the law of the region prior to the enactment of their constitutions.

> "The history of water rights in this State will show that the rights and principles declared in the constitution were recognized and acted upon by the people years before they were formulated and declared in that instrument; that such rights had their inception in the earliest attempt at agriculture, when it was found that climatic conditions demanded the artificial use of water to produce crops. The title of the public and the people to the water in the streams, and the right to divert and appropriate, were recognized and acted upon, the only requirement being an application to a beneficial use; and such rights to the use of water as between different consumers or users were established upon the broad equitable basis that preferences were to be controlled by the respective dates when the conflicting appropriations were made."
>
> *Wyatt et al. v. Larimer & Weld Irrigation Co.*, 1 Colo. App. 480, 497, (29 Pac. 906).

"The common law doctrine relating to the rights of a riparian proprietor in the water of a natural stream, and the use thereof, is unsuited to our requirements and necessities, and never obtained in Wyoming. So much only of the

common law as may be applicable has been adopted in this jurisdiction. The doctrine invoked is inapplicable. A different principle better adapted to the material conditions of this region has been recognized. That principle, briefly stated, is that the right to the use of water for beneficial purposes depends upon a prior appropriation. Our statutes have repeatedly recognized this right, and the constitution of the State declares it. We incline strongly to the view expressed by the Supreme Court of Colorado, to the effect that such right and the obligation to protect it existed anterior to any legislation upon the subject."

Moyer v. Preston, 6 Wyo. 308, 318.

4. Doctrine of Prior Appropriation Strict and Exclusive.

Some confusion has occasionally arisen, and seems to us in this case to have been indulged by the defendants, because of a failure to measure the real doctrine of prior appropriation where it is substituted for the doctrine of riparian rights. When the arid region rejected the doctrine of riparian rights, it was not at all intended that the region should be without any rule as to the use of water. Indeed the customs of the people and the constitutions and laws and rulings of courts substituted a principle even more strict than the common law principle and doctrine of riparian rights. The prior appropriator under the one system

is even more rigidly and strictly protected than the lower riparian proprietor under the other system. In cases of drought and shortage of water, under the common law system the different riparian proprietors were each required to modify their uses of the water in proportion to its deficiency. This resulted from the view that all riparian owners were equal in right, and had an equal right to the customary flow of the water.

On the other hand, the doctrine of prior appropriation by its very expression and by the very rule that "priority of appropriation gives the better right" is exclusive.

> "As opposed to the correlative rights of the common law, whereby all riparian owners on the stream have equal rights, under the law of appropriation the rights of the claimants are unequal. Each has an exclusive right to the extent of his prior appropriation, and appropriations vary greatly in the extent of right appropriated. 'A party appropriating water has the *sole and exclusive* right to use the same for the purposes for which it was appropriated.' So long as the water is put to beneficial use, priority alone governs. Full protection is given to the prior appropriator against all later comers. This exclusiveness includes the right to tributaries and sources, even tributary percolating water so far as proof traces it as tributary, and also storm waters that are of annual occurrence. It is held:

'The prior appropriator of a particular quantity of water from a stream is entitled to the use of that water, or so much thereof as naturally flows in the stream, unimpaired and unaffected by any subsequent changes which, in the course of nature, may have been wrought. To the extent of his appropriation his supply will be measured by the waters naturally flowing in the stream and its tributaries above the head of his ditch, whether those waters be furnished by the usual rains or snows, by extraordinary rain or snow fall, or by springs or seepage which directly contribute.' It is said, 'The appropriator took the water with the right to have the stream flow as it was wont to flow,' which is as strict a statement as the '*aqua currit et debet currere ut currere solebat*' of riparian rights."

1 Wiel on Water Rights (3d Ed.) Section 279.

"But the prior appropriator of the waters of a certain stream has the right to insist that the water continue to flow as it did when he first made the appropriation, as far as the interference by other subsequent appropriators is concerned. 'The appropriator took the water with the right to have the stream flow as it was wont to flow' is the language of the law under the Arid Region Doctrine of appropriation, which is as strict a rule as that of the common law of riparian rights, *aqua currit et debet currere ut currere solebat.* He has also the right to insist on this flow and that no change be made in it by later comers to his material injury."

2 Kinney on Irrigation (2d Ed.) Sec. 801, page 1398.

"It is a recognized rule of law that a person who has appropriated water at a certain point in a stream is entitled to have so much of the waters of said stream as he has appropriated flow down to him to the point of his diversion."

Conant, et al. v. Deep Creek etc. Irr. Co., et al., (23 Utah 627), 66 Pac. 188, 190.

"The reasons which constitute the groundwork of the common law upon this subject remain undisturbed. The conditions to which we are called upon to apply them are changed, and not the rules themselves. The maxim, *sic utere tuo ut alienum non laedas*, upon which they are grounded, has lost none of its governing force; on the contrary, it remains now, and in the mining regions of this State, as operative a test of the lawful use of water as at any time in the past, or in any other country. When the law declares that a riparian proprietor is entitled to have the water of a stream flow in its natural channel *ubi currere solebat* without diminution or alteration, it does so because its flow imparts fertility to his land, and because water in its pure state is indispensable for domestic uses. But this rule is not applicable to miners and ditch-owners, simply because the conditions upon which it is founded do not exist in their case. They seek the water for a particular purpose, which is not only compatible with its diversion from its natural channel, but more frequently necessitates such diversion, and moreover does not require the water in a pure state in order to insure its reasonable and beneficial use. Yet the maxim above mentioned upon which the rule is founded

is equally as applicable to the ditch-owner and to the miner as to the riparian proprietor, and neither can so use the water as to injure or prejudice the prior rights to a like use by the other. This maxim is one which every riparian proprietor is bound to respect, and it is no less obligatory upon those who use and divert water for mining purposes. So that in all controversies like the present the question to be determined after all is the same as that presented by a like controversy between riparian proprietors, to-wit: has the plaintiff's use and enjoyment of the water *for the purposes for which he claims its use* been impaired by the acts of the defendant? This is purely a question of fact for the jury, and all the law applicable to it is found, as stated by the learned counsel for appellants, in the case of the Phoenix W. Co. v. Fletcher (23 Cal. 483), embraced in the three following maxims: *Qui prior est in tempore, potior est in jure; Ubi jus, ibi remedium; Sic utere tuo ut alienum non laedas*; and beyond these principles they do not require to be instructed. What diminution in quantity or what deterioration in quality will injuriously affect the use of the water by the plaintiff may be safely left to the determination of the jury, guided only by the foregoing maxims."

Hill v. Smith, 27 Cal. 476, 482.

"The right to the use of the running water (that is, the right to appropriate water on one's own land) is a corporeal hereditament; but the water when once appropriated includes and comprehends an incorporeal hereditament, to-wit,

the right to have the water flow in the stream, without diminution or deterioration, to the head of the ditch or place of diversion—an easement in the stream, and a servitude upon upper riparian lands."

Smith v. Deniff, (24 Mont. 20), 60 Pac. 398, 400.

"The prior appropriator is clearly entitled to protection against acts which materially diminish the quantity of water to which he is entitled, or deteriorate its quality, for the uses to which he wishes to apply it."

Phoenix Water Co. v. Fletcher, 23 Cal. 482, 487.

"The right acquired to water by an appropriator under our system is of the same character as that defined by the foregoing authorities as an incorporeal hereditament and easement. The consumer under a ditch possesses a like property. He is an appropriator from the natural stream, through the intermediate agency of the ditch, and has a right to have the quantity of water so appropriated flow in the natural stream, and through the ditch, for his use."

Wyatt v. Larimer & Weld Irrigation Co., 18 Colo. 298, (33 Pac. 144, 150.)

"The doctrine that the first appropriator has the superior right, 'where the right to the use of running water is based upon appropriation, and not upon an ownership in the soil,' has been recognized and acknowledged by the decisions

of this Court in Lobdell v. Simpson (2 Nev. 274), and the Ophir S. M. Co. v. Carpenter et al. (4 Nev. 534).

"The facts of this case do not call in question the correctness of the decision in Van Sickle v. Haines (7 Nev. 249), where the title to the land had been obtained from the government prior to the acts of Congress herein referred to.

"It logically follows from the legal principles we have announced that the plaintiff, as the first appropriator of the waters of Currant Creek, has the right to insist that the water flowing therein shall, during the irrigating season, be subject to his reasonable use and enjoyment to the full extent of his original appropriation and beneficial use."

Barnes v. Sabron, 10 Nev. 217, 233.

" 'That a valid appropriation of water from a natural stream constitutes an easement in the stream, and that such easement is an incorporeal hereditament, the appropriation being in perpetuity, cannot well be disputed.' He refers to the discussion of property in water by Washburn in his work on Easements and Servitudes (p. 276), and Angell on Water Courses (Sec. 141), and adds: 'The right acquired to water by an appropriator under our system is of the same character as that defined by the foregoing authorities as an incorporeal hereditament and easement. The consumer under a ditch possesses a like property. He is an appropriator from the natural stream, through the intermediate agency of the ditch, and has the right to have the quan-

tity of water so appropriated flow in the natural stream, and through the ditch for his use.' "

Willey v. Decker, 11 Wyo. 496, 544.

The Act of Congress of July 26, 1866, contains this language:

"Whenever, by priority of possession, rights to the use of water for mining, agricultural, manufacturing, or other purposes, have vested and accrued, and the same are recognized and acknowledged by the local customs, laws, and the decisions of courts, the possessors and owners of such vested rights shall be maintained and protected in the same; and the right of way for the construction of ditches and canals for the purposes herein specified is acknowledged and confirmed."

Revised Statutes, Sec. 2339.
United States v. Rio Grande Dam etc. Co., 174 U. S. 704.

5. Effect of State Lines upon Rights of Appropriators.

The question of the effect of State lines upon the rights of appropriators in different States has been before the courts of the arid region in a number of cases, and so far as we have been able to find has always been decided in the same way. The universal holding is that priority of appropriation gives priority of right on interstate streams the same as on streams wholly within one State.

"We had occasion recently to consider whether the right of a citizen to use water within the State for irrigation of lands is granted by the State or general government, and we were unable to discover any principle of that kind. Mohl v. Lamar Canal Co. (C. C.) 128 Fed. 776. The idea of an exclusive right in the people of a State to divert its running waters to the injury of riparian owners in another State must be equally untenable. Indeed, the doctrine of riparian ownership and use of running water is not subject to political boundaries. Between hostile States the doctrine may not be recognized, but any such repudiation would be simple *vis major*. Between States dwelling in peace and concord, as are the States of our Union, the equal right of the inhabitants of each State to the waters of intersecting streams must always be recognized. Water is essential to human life in the same degree as light and air, and no bounds can be set to its use for supplying the natural wants of men other than the mighty barriers which the Creator has made on the face of the earth.

* * * * * * * * *

"It is enough that complainants and their grantors were in the possession and enjoyment of the water a long time prior to respondents' diversion, and therefore the first appropriators under the law of the land as understood in Wyoming and Colorado."

Hoge v. Eaton, et al., 135 Fed. 411, 414.

The above case was decided by the District Court of the United States for Colorado. The Judge

who sat was on the Supreme Bench of Colorado before the admission of that State into the Union, and became United States District Judge upon the admission. The case was reversed by the Court of Appeals (Eaton v. Hoge, 141 Fed. 64) but the reversal was upon another point and should not weaken the case as authority upon the point here under discussion.

> "It would seem, upon both reason and authority, that the courts of this State, in ascertaining, decreeing, and protecting property rights in water appropriations within the jurisdiction of the State, may at the same time and for that purpose inquire into and determine rights and priorities on the same stream that are located and situated beyond the State line, in order to fairly and finally judicially determine the relative rights of the parties and decree the extent of the title and right of possession of the thing or subject-matter within this jurisdiction. This proposition ought to be accorded a special recognition and application by the courts in water and irrigation litigation. Streams rise in one State and flow into another, irrespective of boundary lines, and still the rules and doctrines of priority of appropriation and use are the same in most of the arid States. This is particularly true with respect to this case. Here the riparian doctrine of the common law has been abrogated in both Idaho and Wyoming, and the rule of 'first in time is first in right' is recognized and enforced in both states. Drake v. Earhart, 2 Idaho, 750, 23 Pac. 541; Moyer v. Preston, 6 Wyo. 308,

44 Pac. 845, 71 Am. St. Rep. 914; Farm Investment Co. v. Carpenter, 9 Wyo. 110, 61 Pac. 258, 50 L. R. A. 747, 87 Am. St. Rep. 918; Willey v. Decker, supra. The relative rights, therefore, of appropriators of the water of an interstate stream are the same, whether the appropriations are all in the same State, or some in one State and the balance in another State. This proposition is accentuated in a case like this, where the court not only has jurisdiction of the res or subject-matter, but also obtains jurisdiction of the person of the defendant. In the case at bar the diversion by the defendants, being the act that causes the injury, takes place in Wyoming; but the injury itself that flows from the wrongful act takes place in this State. It has long been recognized as a general rule that, where an act is committed in one jurisdiction that occasions injury or damage in another jurisdiction, the injured person may elect to bring his action in either jurisdiction."

Taylor v. Hulett, 15 Ida. 265.

"It is a recognized rule of law that a person who has appropriated water at a certain point in a stream is entitled to have so much of the waters of said stream as he has appropriated flow down to him to the point of his diversion; and if the settlers higher up on the stream, in another State, whose appropriations are subsequent, divert any of the waters of the stream which have been so first appropriated, then the courts of the latter State will protect the first settler in his rights. Howell v. Johnson (C. C.) 89 Fed. 556. The Idaho courts, therefore, have ample

and complete jurisdiction to protect the rights of respondents to have the waters which they have appropriated, and which they divert in Utah, flow through the channel of the stream, and to limit and determine the rights of the Idaho appropriators with reference thereto; and by the decree entered in the suit in the district court of Oneida County, Idaho, such rights were fully protected, and may be enforced by proper proceedings in that court."

Conant v. Deep Creek etc. Co., 23 Utah 627.

"This court has stated that the statutory and constitutional declarations seemed rather to declare and confirm a principle already existing than to announce a new one, for the reason that under the rule permitting the acquisition of rights by appropriation the waters became perforce *publici juris*.

* * * * * * * * * * *

"The obvious meaning and effect of the expression that the water is the property of the public is that it is the property of the people as a whole. Whatever title, therefore, is held in and to such water resides in the sovereign as representative of the people. The public ownership, if any distinction is material, is rather that of sovereign than proprietor. (Farm Inv. Co. v. Carpenter, supra.) That ownership however, is subject to a particular trust or use, specially defined in the statutes and in the constitution. And that trust or use, in the absence of statute, is just as prominently and intrinsically attached to such public ownership. The waters are held

subject to appropriation for beneficial uses. And we have endeavored to show that the right of appropriation is not, in the absence of statute at least, restricted locally nor by state lines. The trust is to be considered as co-extensive with the right on which it rests. Upon the general principles governing such appropriation, we perceive no reason, if the same be not prohibited by statute, why the owner of lands in another State may not at a point in this State lawfully divert the water of a stream flowing in both States and conduct such water upon his lands for their irrigation, and thereby secure a valid water right. There is nothing in the essential character of the trust or use for which the waters are held by the public that, in our judgment, prevents the acquirement of a water right on such stream in that manner, provided the appropriator is able to comply with the statutory provisions regulating and controlling the appropriation and diversion of the public waters.

"Moreover, a desirable comity between the States within whose respective dominions the same stream may flow, and a due regard by each for the rights of the residents and land owners in the adjoining State, would seem to require a liberal view of this matter. In an interesting case in Wisconsin, where the question arose whether the State could constitutionally sell the ice formed upon public waters, it was held that where the term 'people of the State' is used to designate the beneficiaries of the trust in navigable waters, all the people who may choose to enjoy the same within the State are referred to,

whether citizens of the State or persons who came within its territory, for the purpose of enjoying such public rights. (Rossmiller v. State, 114 Wis., 169.)"

Willey, et al., v. Decker, et al., 11 Wyo. 496, 533.

Farm Investment Co. v. Carpenter, 9 Wyo. 110.

The case of Howell v. Johnson (C. C. Mont.) 89 Fed. 556, involved a question between Wyoming lands and Montana lands, each party claiming appropriations from a non-navigable interstate stream. The contention was made that the Wyoming citizens owning the Wyoming lands could not maintain the action in Montana because the State of Montana owned the waters in that State. This contention was overruled by the Court, which held that the rights must be determined without reference to State lines.

In the case of Anderson v. Bassman, (C. C. Cal.) 140 Fed. 14, the same question arose between land-owners in California and land-owners in Nevada, each claiming as an appropriator of water from the same non-navigable interstate stream. The Court quotes from the cases of Howell v. Johnson and Hoge v. Eaton, supra, and endorses the views expressed in those cases, saying:

"This court is in entire accord with the views of these two Courts upon this question."

In the case of Morris v. Bean, (C. C. Mont.) 123 Fed. 618, the Court was considering the relative rights of Wyoming and Montana appropriators from the same interstate stream, and held that the prior appropriator is protected in his right "as against subsequent appropriators although the latter withdraw the water within the limits of a different State."

The final hearing of the case was in the same Circuit Court, but before a different Judge.

The contention was again made at the final hearing that an appropriator in Wyoming could not in a court in Montana assert rights as against an appropriator in Montana. The Court overruled this contention, announcing, among other things, the following:

> "In the early stages of this suit Judge Knowles refused to sustain the views thus presented by the defendants. Whether the ruling made is the law of this case does not become material, because the reasons which actuated him in his decision are not only based upon sound principles, but are sustainable upon authority. No case has been cited where the distinction sought to be drawn has prevailed in the courts, but, on the contrary, apparently, wherever the question has arisen the holding has been the other way."
>
> *Morris v. Bean*, 146 Fed. 423.

The case last above cited went to the United States Circuit Court of Appeals for the Ninth Circuit

and was there affirmed, the Court saying, among other things:

> "The right to divert or appropriate for a useful purpose the waters of a non-navigable stream is recognized by the laws of Montana and Wyoming, and by sections 2339 and 2340 of the Revised Statutes (U. S. Comp. St. 1901, p. 1437); and the broad principle which underlies the relative rights of appropriators from the same stream is, that whoever is first in time is first in right, and the fact that the stream, the waters of which are appropriated, is interstate and non-navigable, does not affect the rule."
>
> *Bean v. Morris*, 159 Fed. 651, 655.

A similar question arose in the case of Miller, et al., v. Rickey, et al., (C. C.) 127 Fed. 573. On appeal, the Circuit Court of Appeals for the Ninth Circuit used the following language:

> "The water in the stream, which has a propensity to seek its level, and will continue in its current to the sea, is in strict reality the veritable thing in controversy. It knows not imaginary State or county lines, and is a thing in which no man has a property until captured to be applied to a beneficial use. The right of appropriation is recognized in law, which means the right of diversion and use. It is the right, not to any specific water, but to some definite quantity of that which may at the time be running in the stream. So the right acquired by an appropriation includes the right to have the water

flow in the stream to the point of diversion. The fact of a State line intersecting the stream does not, within itself, impinge upon the right. In other words, the appropriation may still be acquired although the stream is interstate and not local to one State; nor will the mere fact that the stream has its source in one State authorize a diversion of all the water thereof as against an earlier and prior appropriator across the line in another State. On the contrary, one who has acquired a right to the water of a stream by prior appropriation, in accordance with the laws of the State where made, is protected in such right as against subsequent appropriators, though the latter withdrew the water within the limits of a different State."

Rickey Land & Cattle Co. v. Miller, et al., (C. C. A. 9th Cir.) 152 Fed. 11, 17.

The question has been somewhat involved in several cases before this court, but perhaps not clearly or definitely decided.

In the case of Kansas v. Colorado, 185 U. S. 125, and 206 U. S. 46, two sovereign States were litigating as to the waters of the Arkansas River. In that case the State of Colorado claimed the "paramount right to the exclusive use of the water of her natural streams in so far as her necessities require the use of such waters for beneficial purposes within the State." The opinion of the court *arguendo* at least takes strong grounds against the doctrine claimed,

and the general spirit of the decision seems to be against that contention. Besides in that case the court makes use of the following language:

> "Colorado could not be upheld in appropriating the entire flow of the Arkansas River, on the ground that it is willing to give, and does give, to Kansas something else which may be considered of equal value." (206 U. S. 100.)

And at another place in that case this Court said:

> "At the same time it is obvious that if the depletion of the waters of the river by Colorado continues to increase there will come a time when Kansas may justly say that there is no longer an equitable division of benefits and may rightfully call for relief against the action of Colorado, its corporations and citizens in appropriating the waters of the Arkansas for irrigation purposes." (Page 117.)

In another case this Court uses the following language:

> "It is conceivable, to be sure, that the decisions of this court may determine that the States have rights as against each other *in invitum* in streams that flow through the land of both. Kansas v. Colorado, 206 U. S. 46, 84. Missouri v. Illinois, 200 U. S. 496, 519, 520. These rights may vary according to the system of law required by natural conditions. They may be more or less analogous to common law rights between upper and lower proprietors, where irrigation

is not necessary, as in most of the older States. See New York v. Pine, 185 U. S. 93, 96. There may be some, perhaps limited, right of appropriation in the upper State, at least in the watershed of the stream, where irrigation is the condition of using the land. See Kansas v. Colorado, 206 U. S. 46, 100-104, 117. But whatever this court may decide, if a private owner should derive advantage from such a decision it would not be in his own right, but by reason of and subordinate to the rights of his State, and those rights, the petitioner insists, can, or at least should be, determined only in a suit brought by the State itself.

* * * * * * * * *

"We are of opinion that the petitioner fails to establish the conclusion for which it contends. The alleged rights of Miller and Lux involve a relation between parcels of land that cannot be brought within the same jurisdiction. This relation depends as well upon the permission of the laws of Nevada as upon the compulsion of the laws of California. It is true that the acts necessary to enforce it must be done in California and require the assent of that State so far as this court does not decide that they may be demanded as a consequence of whatever right, if any, it may attribute to Nevada. But, leaving the latter possibility on one side, if California recognizes private rights that cross the border line, the analogies are in favor of allowing them to be enforced within the jurisdiction of either party to the joint arrangement."

Rickey Land & Cattle Co. v. Miller & Lux, 218 U. S. 258.

And in still another case this Court uses this language:

> "We know no reason to doubt, and we assume, that, subject to such rights as the lower State might be decided by this court to have, and to vested private rights, if any, protected by the Constitution, the State of Montana has full legislative power over Sage Creek while it flows within that State. Kansas v. Colorado, 206 U. S. 46, 93-95. Therefore, subject to the same qualifications, we assume that the concurrence of the laws of Montana with those of Wyoming is necessary to create easements, or such private rights and obligations as are in dispute, across their common boundary line. Missouri v. Illinois, 200 U. S. 496, 521. Rickey Land & Cattle Co. v. Müller & Lux, 218 U. S. 258, 260. But with regard to such rights as came into question in the older States, we believe that it always was assumed, in the absence of legislation to the contrary, that the States were willing to ignore boundaries, and allowed the same rights to be acquired from outside the State that could be acquired from within. Mannville Co. v. Worcester, 138 Massachusetts, 89. Thayer v. Brooks, 17 Ohio, 489. Slack v. Walcott, 3 Mason, 508, 516. Stillman v. White Rock Manuf. Co., 3 Woodb. & M. 538. Rundle v. Delaware & Raritan Canal Co., 1 Wall. Jr. 275, 14 How. 80. Foot v. Edwards, 2 Blatchf. 310. See Wooster v. Great Falls Manuf. Co., 5 Maine, 246, 253, Armendiaz v. Stillman, 54 Texas, 623; State v. Lord, 16 N. H. 357. Howard v. Ingersoll, 17

Alabama, 780, 793. There is even stronger reason for the same assumption here. Montana cannot be presumed to be intent on suicide, and there are as many if not more cases in which it would lose as there are in which it would gain, if it invoked a trial of strength with its neighbors. In this very instance, as has been said, the Big Horn, after it has received the waters of Sage Creek, flows back into that State. But this is the least consideration. The doctrine of appropriation has prevailed in these regions probably from the first moment they knew of any law, and has continued since they became territory of the United States. It was recognized by the statutes of the United States, while Montana and Wyoming were such territory, Rev. Stat., Secs. 2339, 2340, p. 429, Act of March 3, 1877, c. 107, 19 Stat. 377, and is recognized by both States now. Before the State lines were drawn of course the principle prevailed between the lands that were destined to be thus artificially divided. Indeed, Morris had made his appropriation before either State was admitted to the Union. The only reasonable presumption is that the States upon their incorporation continued the system that had prevailed theretofore, and made no changes other than those necessarily implied or expressed. See Willey v. Decker, 11 Wyoming, 496; Smith v. Deniff, 24 Montana, 20."

Bean v. Morris, 221 U. S. 485.

"The rights of the respective States and of the citizens thereof in and to the use of waters

of an interstate stream depend somewhat upon the laws of those States governing waters. If the common law is the only law of waters governing two adjoining States through which an interstate river flows, or if both States have adopted the Arid Region Doctrine of appropriation, the right to the use of the waters of an interstate stream is not affected by the boundary line which divides the States. But where there is conflict of the laws relative to the subject of water, that is to say, the lower State upon the stream having only the common law of riparian rights, and the upper State having adopted the Arid Region Doctrine of appropriation, the rule is different, and will be discussed in a subsequent section of this chapter.

"The rights as between appropriators of the waters of an interstate stream are not affected by the boundary line between the two States. As was said by a Wyoming case: 'The separation of lands capable of irrigation from such streams is of no consequence.' As was said in a recent Idaho case, 'The relative rights, therefore, of appropriators of waters of an interstate stream are the same, whether the appropriations are all in the same State or some in one State and the balance in another State.' 'The right to divert running waters for irrigating lands in an arid country is not controlled or affected by political divisions. It is the same in all States through which the streams may pass.' "

3 Kinney on Irrigation, (2d Ed.) Sec. 1225, page 2216.

The case of Kansas vs. Colorado is perhaps

the only case which has been before this court in which the rights pertaining to the States as such, in distinction from the rights of the citizens of different States, with respect to the use of waters of interstate streams for irrigation, have received consideration. Indeed no other court could entertain a controversy over this subject or authoritatively dispose of such controversy.

> "It is recognized that the State as quasi-sovereign and representative of the interests of the public has a standing in court to protect the atmosphere, the water, and the forests within its territory irrespective of the assent or dissent of private owners of the land most immediately concerned."
>
> *Hudson Water Co. v. McCarter*, 209 U. S. 349, 355.
> *Georgia v. Tenn. Copper Co.*, 206 U. S. 237.
> *Kansas v. Colorado*, 206 U. S. 99.

It was pointed out in the Kansas-Colorado case that there was no written law, nor, under the constitution, any legislative power, to furnish a rule by which such controversy could be determined; but that the power (and of course the corresponding duty) rested upon this court, as the general reservoir of the judicial power of the United States, to furnish such rule, (206 U. S. 95).

Naturally the court in exercising this power will

have regard for the natural laws peculiar to the subject and the common experience of mankind, especially as such experience is embodied in the systems of law which, through the ages, have been established to deal with a subject which is not local or temporary but universal and lasting in its nature.

Climatic and other physical conditions vary greatly in the different regions of the earth, and social conditions, if not physical conditions, change profoundly from age to age as well as with change of place.

One cannot obtain a just and comprehensive view of the rights and relations of different riparian owners merely from observation of the local or particular customs prevailing in any one place or at any one time. Ephemeral conditions or circumstances may seem important, and they do influence largely the actual conduct of men. The controversy before the court in this case, however, is merely a small, concrete part of a question of wide range and scope, which presents a certain solidarity not to be lost sight of in disposing of a single law suit. The question presented to-day between Wyoming and Colorado will to-morrow arise between Wyoming and Nebraska, or between Colorado and Nebraska, between Montana and one or both of the Dakotas, between Idaho on the one hand and Washington or Oregon on the other hand, between Colorado and Utah on one side and

Arizona or California on the other. Indeed there is no reasonable limit which can be set to the locations or circumstances and conditions under which water rights may be brought in controversy between different States or the citizens of different States, thus bringing into direct conflict opposing or varying State policies.

Wyoming and Colorado on the upper reaches of the great rivers, at the crest of the continent, may not be early called upon to consider seriously riparian rights; but the communities of the east as well as those of the extreme west have had to consider such rights most seriously, to test the different doctrines in a variety of circumstances, and to choose that which seemed best to promote the general welfare. The States bordering on the Pacific, as well as those along the Missouri River and other streams to the east, generally recognize the doctrine of prior appropriation of water, if at all, only in subordination to the doctrine of riparian rights. This court will unquestionably be called upon often and urgently to reconcile these two doctrines or at least make it possible for them to dwell in harmony in the neighboring States of a common country. Therefore, it is important that the court in the present case should consider the question in its larger aspects, since it is unthinkable that a rule of interstate relations can be established

and maintained between Colorado and Wyoming which is opposed to, or materially different from, the rule determining such relations between Wyoming and Nebraska. Streams which rise in Colorado flow through Wyoming into Nebraska. It would establish chaos rather than order to apply one rule between Colorado and Wyoming and a different or inconsistent rule between Wyoming and Nebraska respecting their several rights to the integral flow of the North Platte River or the Laramie River.

We feel bound to concede that the common law doctrine of riparian rights is substantially a world doctrine which has persisted throughout historical times. It was the Roman law, as appears from the Pandects of Justinian; it is the modern French law, embodied in the Code Napoleon (article 644); it was the Spanish law, or at least the Mexican law at the time of the acquisition of our Mexican territory (1 Wiel on Water Rights 68, 685, 1026); and of course it has been the law of English speaking countries from time immemorial. Irrigation has been practiced beyond memory in all of these jurisdictions under conditions where it seemed to be a required or natural use. Therefore, it would seem to be axiomatic that the use of water for irrigation is not necessarily inconsistent with the doctrine of riparian rights.

Yet it has often been said by the courts of certain

States in the arid regions (including those of Wyoming and Colorado) that the doctrine of riparian rights cannot co-exist with the doctrine of appropriation and has been abrogated by the latter, wherever established by custom or by written laws. The question, therefore, recurs and persists whether there is room in a single country at the same time for the two doctrines—whether they can be reconciled and brought into harmonious relation through the functions of this court in disposing of interstate controversies. It may not, and probably will not, be found necessary in this case to settle or determine the controlling principles of interstate water rights. We are simply suggesting that the elements of the present controversy are an inseparable part of the question in its larger and final form.

In the present case, as we have already pointed out, Colorado and her citizens are not regulating their conduct by either of the two doctrines referred to. Having exercised all the rights of riparian ownership and also their rights of appropriation to a point near the limit of supply in the valley of the Poudre River itself, and having helped themselves somewhat liberally in previous years to supplies from neighboring streams, they now propose to seize a third or a half of the supply of another watershed, scuttle its basin and divert the flow from those who have the highest

natural and moral, as well as legal right, to supply their own necessities within the valley of the Laramie. Many instances were testified to by Professor Carpenter, who testified for Colorado, where diversions had been made in various quarters of the world from one watershed to another; but with one exception presently to be mentioned, no objection was known to have been raised and no injury was known to have been sustained by reason of such diversions. Under the riparian doctrine we have been able to find but a single case which can be taken even on trust as authority for such an act. In the case of Jones vs. Conn. 39 Ore. 30, 64 Pac. 855, it appeared that an appropriator had led water from the stream to the opposite side of a bluff, whence the seepage would not return to the parent stream. It did not appear that the water was actually diverted into another watershed. This was held to be a permissible use as against the riparian owners. On the other hand it seems to be thoroughly well established that such conduct is not consistent with the rights of riparian proprietors where such rights are recognized, and that lands beyond the watershed are not riparian to the stream.

1 Wiel on Water Rights (Third Edition) p. 849.

1 Kinney on Irrigation, p. 782.

2 Farnham on Waters 1572, 3 Id. 1903.

Wiggins vs. Water Co., 113 Cal. 182, 45 Pac. p. 160.
Bathgate vs. Irvine, 125 Cal. 135, 58 Pac. p. 442.
Southern Cal. Inv. Co. vs. Wilshire, 144 Cal. 68.
Anaheim Union Water Co. vs. Fuller, 150 Cal. 327, 88 Pac. 978, 980.
Clark vs. Allaman, 71 Kans. 206, 80 Pac. 571, 585.
Watkins Land Co. vs. Clements, 98 Tex. Civ. App. 578.
Matagorda Canal Co. vs. Markham Irr. Co., ...Tex. Civ. App.....154 S. W. 1176.
McCarter vs. Hudson Water Co., 70 N. J. E. 695, 65 A. 489, 494.

For the most part the cases cited were decided by courts of States where the right of prior appropriation is recognized but in subordination to riparian rights. Apparently the underlying physical or natural reason of these decisions is the fact that water diverted beyond the watershed does not return in whole or in part to the parent stream as it does when used within the watershed. The obligation to return surplus water is very generally established in the arid States by statute or the decisions of courts.

1 Wiel on Water Rights 282.
Hutchinson vs. Watson Ditch Co., 16 Ida. 484.

Colorado alone seems to have dissented from this rule.

Coffin vs. Left Hand Ditch Co., 6 Colo. 443.

Even there it is not permitted to change the use, under an appropriation once established, so that the surplus water will not return to the stream.

Ft. Collins M. & E. Co. vs. Larimer & Weld Irr. Co., . . .Colo. . . . . 156 Pac. 140, 143.

Conceding this to be the domestic rule established in Colorado such rule cannot, as was said by this court in the Kansas-Colorado case, be imposed upon other States.

Each watershed has a natural unity and sanctity of its own. There can be no equitable division of its waters between lands or inhabitants within the watershed and those located in other watersheds, which does not recognize the laws of nature and the natural preference which is inherent in the lands and people of the valley. The taking away of surplus waters which the inhabitants do not need and cannot use would perhaps be *damnum absque injuria.* Colorado again pays tribute to the natural integrity of a watershed by certain constitutional provisions preferring certain natural uses of riparian owners to the right to deplete the stream by appropriation. Under Section 6 of Article 16 of the State Constitution, declaring such preferences, the Supreme Court of Colorado has said:

> "*The use protected by the constitutions is such as the riparian owner has at common law to take*

water for himself, his family, or his stock and the like."

Montrose Canal Co. vs. Loutsenhizer Ditch Co., 23 Colo. 233.

Another inherent limitation upon the use of running streams is expressed in the general agreement that "Neither sovereign nor subject can acquire anything more than a mere usufructuary right therein."

Sweet vs. Syracuse, 129 N. Y. 335.

And this proposition holds good equally under the riparian doctrine and under the appropriation doctrine.

1 Wiel on Water Rights 18.
Kidd vs. Laird, 15 Cal. 162.

Being a usufructuary right rather than a right of absolute dominion it follows that an appropriator no more than a riparian owner can divert water from a stream arbitrarily or without putting it to use, but in doing so he takes the water, as it were, upon trust to apply it to a beneficiary use recognized by the law, and to return all that is not needed for such use. This he may well do where the water is not withdrawn from the watershed; when that is done it is beyond his power to return it and the mischief of an over-diversion is irremediable.

It would be interesting to discuss the historical development of the doctrine of appropriation, but

this would be impracticable within the limits of this brief. We content ourselves with a summary of the discussion found in the works of a philosophical and accurate writer of authority on this subject. In the third edition of his work on Water Rights, Mr. Wiel shows in a very clear and comprehensive way that the doctrine of appropriation, as it is recognized in the arid regions of the western States, had its origin among the miners of California where the custom grew up to divert the water of the mountain streams for the purposes of hydraulic mining—a use which did not consume the substance of the water, though it often impaired its quality—and which was determined as to its location by the presence of gold bearing deposits.

When this practice attained a growth and prevalence which demanded legislative recognition, both at the hands of the States and in Congress, the expression of these customs in the statutes was found generally in legislation defining mining rights, though in the case of the Act of Congress it comprehended "mining, agriculture, manufacturing, or other purposes", (R. S. U. S. 2339, A. C. July 26, 1866).

Thus it came about that mining customs with respect to the use of water became applicable to its use by irrigators, and many courts in defining these customs have applied them indiscriminately without

taking into consideration their origin or the essential differences between the two diverse uses.

1 Wiel on Water Rights 66-122.

The pioneer case in this court also discusses the origin and development of these customs in an illuminating way and applies them with a more discriminating understanding to rights of appropriation for the purposes of irrigation.

Speaking of the "paramount right" of the prior appropriator (where there were no riparian rights involved) it was said that such right was to be "exercised within reasonable limits, for this right to water, like the right to prior occupancy of mining ground, or agricultural land, is not unrestricted. It must be exercised with reference to the general condition of the country and the necessities of the people and not so as to deprive a whole neighborhood or community of its use and vest an absolute monopoly in a single individual."

Basey vs. Gallagher, 20 Wall. 670.

The courts of California, where the doctrine of appropriation originated, in the manner already shown, might perhaps have been expected to deal with the subject, in the development of water law, with the intelligence born of familiarity with the actual conditions out of which the customs grew into law. In

that State the courts harbored no delusion on the subject of the inherent strength and wide prevalence of the doctrine of riparian rights. It was never thought in California that the necessity of extending the use of water in arid regions called for the subversion or the destruction of this doctrine; and in the case of Lux vs. Haggin, 69 Cal. 255, and subsequent cases, that doctrine has been emphatically declared and perpetuated alongside, and in greater or less harmony with, the doctrine of appropriation. The other Pacific States have generally followed this policy.

On the other side of the Rocky Mountains will be found either a want of coherent doctrines, an avoidance of determination or a more or less curious mixture of the two doctrines, as illustrated in the following cases:

Winters vs. U. S., 143 F. 740, 749; 207 U. S. 564, 578.
Bigelow vs. Draper, 6 N. D. 152.
Lone Tree Ditch Co. vs. Cyclone Ditch Co., 15 S. D. 519, 26 S. D. 307.
Sturr vs. Beck, 133 U. S. 541.
Crawford Co. vs. Hathaway, 60 Neb. 754; 67 Neb. 325.
Clark vs. Allaman, 71 Kan. 206.
Barrett vs. Metcalf, 12 Tex. Civ. App. 247.
Hall vs. Carter, 33 Tex. Civ. App. 230 and other cases;

so that from Montana to Texas, the States of this region have shown a tendency to maintain

with greater or less modification, both doctrines concurrently. It is only in the States lying along the crest of the mountains that we find the extreme views already referred to, announced by the courts, that the doctrine of appropriation has superseded and destroyed the doctrine of riparian rights.

At page five of the Bill of Complaint can be found a reference to the derivation of the territory including the Laramie Valley in Wyoming from the territory of Dakota. This fact gives to the doctrines of North and South Dakota and the discussion of the subject in the case of Sturr vs. Beck, supra, special significance. In the transition from Dakota to Wyoming the settlers in the Laramie Valley of course took with them whatever rights had accrued and become vested under the Dakota laws.

6. The Contention that Colorado as a Sovereign State may do as she will with Waters Found within her Boundaries Regardless of Resulting Injuries to Others.

(a) In presenting a demurrer to the petition in this case, the defendant, The State of Colorado, contended that as a sovereign it is not bound to recognize any rights to waters in controversy in favor of the plaintiff or its citizens, contending that as an absolute sovereign within its own limits it has the right to

avail itself, without restriction, of everything found within its boundaries, answering to no one for the use it may make of whatever it finds there. In support of this contention, the defendant, The State of Colorado, cited an opinion by Judson Harmon, Attorney General of the United States, given in 1895. (Opinions of the Attorneys General, Vol. 21, page 274,) and also cited the case of Hilton v. Guyot, 159 U. S. 113.

It is true that Mr. Harmon, as Attorney General, in the opinion cited, used this language:

> "The case presented is a novel one. Whether the circumstances make it possible or proper to take any action from considerations of comity, is a question which does not pertain to this Department; but that question should be decided as one of policy only, because, in my opinion, the rules, principles, and precedents of international law impose no liability or obligation upon the United States."

If by the word "novel" the Attorney General intended to say that the question was one of first impression, he was apparently, to some extent at least, in error. On June 12, 1880, Mr. Evarts, as Secretary of State, enclosed to the United States Legation in Mexico certain complaints from citizens of Texas living on the Rio Grande. These complaints were to the effect that certain Mexicans in Mexico were in the habit of diverting the waters of the Rio Grande

into their ditches, thereby preventing the complainants from obtaining water for the irrigation of their crops.

> "This", said Mr. Evarts, "if true, would be in direct opposition to the recognized rights of riparian owners, and, if persisted in, must result in disaster and ruin to our farming population on the line of the Rio Grande, and might eventually, if not amicably adjusted through the medium of diplomatic intervention, be productive of constant strife and breaches of the peace between the inhabitants of either shore."
>
> 1 Moore's Dig. Int. L. 653.

It is worthy of notice that the complaints made by the Mexican Minister concerning which the opinion of Mr. Attorney General Harmon was written, continued in one form or another for many years after 1895. They resulted in an action brought by the Attorney General of the United States in the District Court of the Third Judicial District of New Mexico against the Rio Grande Dam & Irrigation Company on May 24, 1897. That case reached this Court, and is found as United States v. Rio Grande Dam & Irrigation Company, 174 U. S. 690. The complaint still persisted, and resulted in a special treaty confined to the distribution of the waters of the Rio Grande. In that treaty between the United States and Mexico, the United States agreed, without expense to Mexico,

to furnish and deliver to Mexico 60,000 acre feet of water annually. Mexico agreed on its part in consideration of the delivery of the water above stated, to waive any and all claims to the waters of the Rio Grande between the head of the Mexican Canal and Fort Quitman, Texas, and also declared fully settled and disposed of and waived "all claims heretofore asserted or existing, or that may hereafter arise, or be asserted, against the United States on account of any damages alleged to have been sustained by the owners of land in Mexico, by reason of the diversion by citizens of the United States of waters of the Rio Grande." (34 Statutes at Large, Part 3, Page 2953.)

It is true that the United States in that treaty stipulated that it did not concede any basis for the claims asserted by Mexico, nor concede the establishment of any general principle or precedent by the concluding of the treaty.

(b) In our view, the cases above cited, where courts of the arid region uniformly have disregarded State boundaries in determining questions of right in and to the waters of interstate streams, are strong authorities in point against the contention of Colorado. It would indeed be an anomaly if on an interstate stream the private citizen in one State in a court of justice could sustain his right against a citizen of the

upper riparian State, while the State might not in behalf of numerous of its citizens in like case as *parens patriae*, trustee, guardian, or representative be able to enforce the same rights.

Colorado, as well as Wyoming, has uniformly held that as between individuals no upper riparian proprietor has any right to divert waters from the stream if such diversion shall deprive a lower appropriator from the stream of any portion of the water to which he is entitled. The holding is that the lower appropriator by being prior in time acquires not only a moral right but a right of such force and quality as to be available in a court of equity against the upper riparian proprietor who attempts by later appropriation to deprive the prior appropriator of any portion of his water. The holding of both of these States, and of other States in the arid region, is that the inherent principles of equity require the recognition of the rights of the prior appropriator as of full force, and that the upper riparian proprietor has no right, either growing out of his position as upper proprietor or otherwise, to diminish the flow required by the prior appropriations of the lower proprietor. The fact that he finds the waters on his premises gives him no right whatever to invade the strong equitable, and indeed legal right, which all of the arid States insist has been acquired by the prior appropriation,

and every court that has been required to pass upon the question holds that the interposition of a State boundary in nowise affects the validity of these private rights.

If it is equitable as between individuals that the prior appropriator shall be prior in right, it is difficult to see why the equity should not be the same if the two proprietors happen to be States instead of individuals. Shall not a State also do equity?

(c) Colorado and Wyoming were a part of the public domain, with no State boundary between them, at a time when, according to the decisions of both States, the doctrine of prior appropriation was in force here. Neither State had been admitted into the Union when Congress enacted the law of 1866. Indeed many of the prior appropriations made in Wyoming from the stream in controversy, as shown by the evidence here, were made when no State boundary had been interposed between the source and the mouth of the Laramie River. The language of this Court in the case of Bean v. Morris, 221 U. S. 485, is applicable here. In that case this Court said:

> "The doctrine of appropriation has prevailed in these regions probably from the first moment that they knew of any law, and has continued since they became territory of the United States. It was recognized by the statutes of the United

States, while Montana and Wyoming were such territory, and is recognized by both States now. Before the State lines were drawn of course the principle prevailed between the lands that were destined to be thus artificially divided. Indeed, Morris had made his appropriation before either State was admitted to the Union. The only reasonable presumption is that the States upon their incorporation continued the system that had prevailed theretofore, and made no changes other than those necessarily implied or expressed."

In the case of Bean v. Morris last above cited, this Court used this further language:

"But with regard to such rights as came into question in the older States, we believe that it always was assumed, in the absence of legislation to the contrary, that the States were willing to ignore boundaries, and allowed the same rights to be acquired from outside the State that could be acquired from within." Citing, Mannville Co. v. Worcester, 138 Massachusetts, 89. Thayer v. Brooks, 17 Ohio, 489. Slack v. Walcott, 3 Mason, 508, 516. Stillman v. White Rock Manuf. Co., 3 Woodb. & M. 538. Rundle v. Delaware & Raritan Canal Co., 1 Wall. Jr. 275, 14 How. 80. Foot v. Edwards, 3 Blatchf. 310. Wooster v. Great Falls Manuf. Co., 39 Maine, 246, 253. Armendiaz v. Stillman, 54 Texas, 623; State v. Lord, 16 N. H. 357. Howard v. Ingersoll, 17 Alabama, 780, 793.

(d) The decisions of this Court in the case of

Kansas v. Colorado, seem to us to go far towards denying the defense that Colorado attempts to make in this case through its alleged rights as a sovereign State. In passing on the demurrer in that case, the Court considers, first, the question whether the cause of action presented there was of a justiciable nature. This discussion arose upon a claim there made on behalf of Colorado on the ground of its sovereignty identical with the claim here. This court, after reviewing a number of earlier decisions of the Court on the question of controversies between States, used this language:

> "Applying the principles settled in previous cases, we have no special difficulty with the bare question whether facts might not exist which would justify our interposition."
>
> *Kansas v. Colorado*, 185 U. S. 125, 144.

In the decision of that case on the merits, while the State of Kansas was denied relief upon the facts, the Court uses this language:

> "It is obvious that if the depletion of the waters of the river by Colorado continues to increase there will come a time when Kansas may justly say that there is no longer an equitable division of benefits and may rightfully call for relief against the action of Colorado, its corporations and citizens in appropriating the waters of the Arkansas for irrigation purposes."
>
> *Kansas v. Colorado*, 206 U. S. 46, 117.

The defendants have sought to weave into a defense several theories.

One of the matters sought to be proven is that there is a very large mean flow of water in the Laramie River. Upon this the defendants produce the theories of Mr. Field, formed not from his own observations but from observations and records made by others. In reaching his results, moreover, this witness, as we have seen, accepts and uses the high figures of the various observers, and rejects figures showing low stream flow, and only low figures.

Over against the theories of the defendants so formed, the plaintiff has given the actual computations of the witness Meeker, made from his own actual observations and measurements. Besides this testimony the plaintiff has also put in evidence the acid test of experience—the actual share of the river's flow that is required by the lands irrigated in Wyoming, as determined by the actual experience of many years. This actual experience discloses that in every year save two, there were no surplus waters in the stream above the amount required for the irrigation of the Wyoming lands, and that on the contrary there was in several of the years an actual shortage of water to such an extent that owners of lands under the Wheatland project actually assessed themselves $2.50 per acre in order to increase their insufficient supply of water.

Not only is the preponderance of the evidence with the plaintiff as to the amount of the annual flow of the Laramie River and therefore the amount of the so-called mean flow but the law and the evidence make plain that the mean flow of the river bears but slightly upon any matter here in issue.

The heavy flow of the floods in the river cuts no figure in the case of one who takes water for his needs from day to day out of the river channel. The excess flow above his requirements yesterday would have done him damage rather than benefit if flooded over his lands. At least it has passed on down the river and is not available to meet the deficiency in to-day's supply.

The appropriator is not required, as against one who comes later to the stream, to store the surplus of the floods. He may equitably insist that to the extent of his requirements the stream shall flow down to him each day as it has been wont to flow. This is the equitable rule which, as we have seen, is reached by all the authorities, and the reasons for it are too plain to require argument.

In this case even the aggregate flow is required by the prior appropriators in Wyoming, much more is it true that the reduced flow of later June and the whole of July and August is already below the requirements of the prior Wyoming appropriators.

But it is urged that we should not be permitted to retain and use the water, although our appropriations are prior to those of the defendant, because the water can be made more valuable in the Poudre Valley in Colorado. The fact that the water can be made more valuable there must be conceded on the evidence. This has nothing which seems to us even remotely a ground for depriving the Wyoming appropriators of their prior right. The use of the water in Wyoming has been beneficial. This is all that is required.

In a contest for property of any kind we have never known a case where it was held material that one of the parties could make better use of the property involved than the other.

We submit that the defendants should be enjoined as prayed.

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OCTOBER TERM, 1916.

No. 8, Original.

IN EQUITY.

THE STATE OF WYOMING, COMPLAINANT,
vs.
THE STATE OF COLORADO, THE GREELEY-POUDRE IRRIGATION DISTRICT, AND THE LARAMIE-POUDRE RESERVOIRS & IRRIGATION COMPANY, DEFENDANTS.

BRIEF FOR DEFENDANTS.

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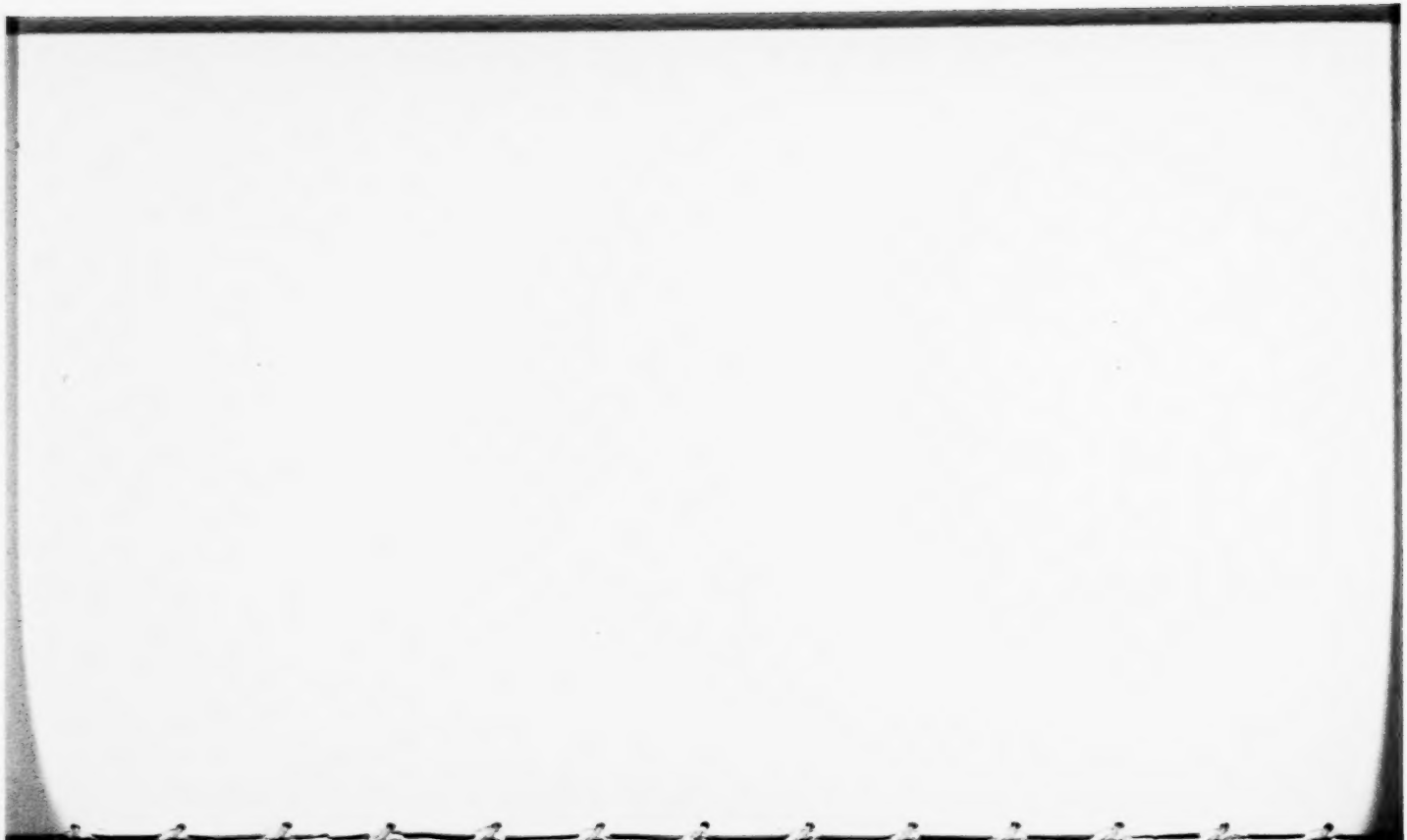
NOTE

The original transcript, together with all exhibits in this case, is filed in the office of the Clerk of the Court at Washington. This original transcript consists of nine volumes of typewritten matter, the first three being the evidence of the complainant in chief, the fourth to eighth, inclusive, the evidence introduced by the defendants, and the ninth complainant's evidence in rebuttal.

Pursuant to an order of court, an abstract of this evidence containing certain selected exhibits has been printed with the pleadings, the motions, orders, etc. In this abstracted transcript, which consists of two volumes, so printed, the pages of the original transcript are shown in the margin and it is these original transcript pages or marginal abstract pages to which reference is made in this brief.

This brief consists of two volumes, the first being a general treatment of the facts and the law; the second volume is devoted exclusively to a discussion of the facts and the law relating to Inter-watershed Diversions and Priority of Diversions, the evidence upon these two subjects being so voluminous and complicated that it was thought better to treat the discussion of them in a separate volume rather than to attempt to incorporate it into the main brief.

A brief descriptive list of defendants' exhibits is placed in an appendix at the end of each volume of this brief.



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In the Supreme Court of the United States.

OCTOBER TERM, 1916.

No. 7, Original.

THE STATE OF WYOMING, COMPLAINANT,
vs.
THE STATE OF COLORADO, ET AL., DEFENDANTS.

BRIEF FOR DEFENDANTS.

This is an original proceeding in this court, instituted by the State of Wyoming as Complainant, vs. The State of Colorado, The Greeley-Poudre Irrigation District and The Laramie-Poudre Reservoirs & Irrigation Company as Defendants, to enjoin a present and threatened diversion of water from the interstate stream, the Laramie River. The diversion is made from a section of the stream within Colorado and the irrigation system and point of application are within that state. The stream is non-navigable.

The cause came on upon demurrer, the demurrer was overruled without prejudice, and the cause ordered heard upon the merits. In course, answers were filed by the defendants, and a replication thereto by the complainant. Other mention of these pleadings is unnecessary at this stage.

The action was instituted in May, 1911. The controlling facts are without dispute. The court will take judicial notice of many of the most important facts, and as to such facts as are in conflict, the conflict is of such a character as not to affect the merits of the case.

> "It has been very justly observed at the bar that the court is bound to take notice of public facts and geographical positions."
>
> United States vs. Rio Grande Irr. Co., 174 U. S., 690

"The law of any state of the Union, whether depending upon statutes or upon judicial opinions, is a matter of which the courts of the United States are bound to take judicial notice."

Lamar vs. Micou, 114 U. S., 218, 223.

It is thought the case will not turn upon any nice distinctions of fact.

The facts, certain of which will be hereafter discussed under subheads, are these: The Laramie River rises in the Medicine Bow and Green Mountains in Larimer County, Colorado, flows thence northerly through a narrow valley lying between the Medicine Bow Mountains and the Green Mountains, a distance of about 27 miles, to the Colorado-Wyoming line, thence through the Laramie Plains in a northeasterly direction. The Laramie is joined on the Laramie Plains by the Little Laramie before it reaches the Wheatland Reservoir, a channel reservoir. The river flows thence through the mountains and on past the Wheatland country to its junction with the North Platte River at Fort Laramie. Among other tributaries to the stream in this last mentioned section are the North Laramie, the Sybille and the Chugwater streams. The length of the stream from its origin in the Medicine Bow mountains to its union with the North Platte River at Fort Laramie is 150 miles or more.

Substantially all of the tributaries of the Laramie River which drain the Colorado watershed, except Sand Creek, Johnson Creek and Beaver Creek, join the river before it reaches the Colorado-Wyoming line. This Colorado drainage area is 393 square miles, and while there is some conflict as to the run-off therefrom, which conflict will be later discussed, we are justified for the present consideration in stating it to be, at the Colorado-Wyoming line, an annual run-off of 250,000 to 300,000 acre feet. The total drainage area of the Laramie River is 4,076 square miles, about 3,600 square miles of which drainage area is within the State of Wyoming, no part of which drainage area within Wyoming contributes to the diversions sought to be enjoined in this suit or any other diversions which it is practicable for Colorado to make in the future. Only 63.5 miles of this drainage area within Colorado is tapped by the diversion sought to be enjoined herein. The total run-off of the Laramie River in Colorado and Wyoming is in excess of 470,000 acre feet. The only portion of the Colorado run-off that can be availed of in the State of Colorado within the watershed of the Laramie River is that portion which is applied upon 4,250 acres which lie along the section of the stream within the State of Colorado and constituting the narrow valley herein-

before mentioned. The only water that can be diverted from the upper reaches of the Laramie River or any other part of the stream for use within the State of Colorado is a maximum of 91,000 acre feet and it can only be availed of by carrying it to another watershed. Natural conditions have placed a limitation upon the possibility of diverting any larger amount of water from the Laramie River for uses in Colorado.

Some years ago a diversion was made by the Sky Line ditch from a section of the Laramie River in the Medicine Bow Mountains, and the water carried over and dropped into the Poudre River and applied for irrigation purposes to lands in the Poudre Valley, another watershed. The average possible diversion through this ditch is 16,000 acre feet annually.

Another diversion from a tributary of the upper section of the Laramie River is the Sand Creek diversion of 4,000 acre feet annually. This water is carried from Sand Creek into Sheep Creek and thence for irrigation purposes in the Poudre Valley.

These two diversions, aggregating 20,000 acre feet, are not attacked in this proceeding. These diversions cannot be enlarged. The actual diversion that is being attacked is 56,000 acre feet annually, which the evidence shows can be diverted through what is known as the tunnel and the tunnel reservoir. This water is to be conveyed through the tunnel, thence into the Poudre River, a tributary of the South Platte River, and thence on for application to a beneficial use in the Greeley-Poudre District.

It is possible for the Greeley-Poudre District to enlarge this diversion of 56,000 acre feet by 15,000 acre feet through certain collection ditches which might be constructed to a tributary known as McIntyre Creek on the Colorado section of the Laramie watershed. If the enlarged diversion be made, the aggregate diversion through the tunnel will be 71,000 acre feet. This actual and proposed diversion is attacked in this proceeding, that is, Wyoming is not contesting the diversions of 16,000 acre feet through the Sky Line Ditch or the 4,000 acre feet diversion through Sand Creek, but is contesting the present and proposed diversion through the tunnel which may reach an aggregate of 71,000 acre feet. Wyoming is thus contending that from a run-off of 470,000 acre feet of an interstate stream, 300,000 acre feet of which is provided by the Colorado watershed and enters the stream within Colorado, Colorado should have 20,000 acre feet and Wyoming 450,000 acre feet.

As hereinbefore stated, the aggregate diversions that are possible from the Colorado section of the Laramie River watershed are 91,000 acre feet. If this bill be dismissed, the Colorado interests will be entitled, without question, to make aggregate diversions of 91,000 acre feet.

The State of Colorado is here represented by her Attorney General, insisting upon and claiming the right in her sovereign capacity to divert the 91,000 acre feet annually. The controversy is not between private parties; it does not involve a question of private interests, but is between the two sovereignties of Wyoming and Colorado, Wyoming denying the right of Colorado to avail herself of a reasonable part of this great natural resource and Colorado insisting that it is a reasonable exercise of one of her rights as a sovereignty to appropriate from this great natural resource which is originated and created within her limits the 71,000 acre feet sought to be enjoined herein.

Colorado became a state in 1876. At that time there were no diversions from the Laramie River in the State of Wyoming except two small diversions, aggregating not to exceed 51.33 second feet, which diversions cannot be affected by the diversion which Colorado herein insists upon her right to make. The question of vested rights, therefore, cannot arise in this proceeding.

Wyoming became a state in 1890. The two new states came in with equal rights and vested with all of the rights as to their respective natural resources as were held by the original thirteen states.

Every diversion that Wyoming citizens had made prior to 1890 from the Laramie River, and also those subsequent to 1890, can be satisfied without impairing the diversions, the rights to which are insisted upon by Colorado in this proceeding. When Colorado became a state, there was no appropriation in Wyoming but what could be satisfied and yet have an excess of water to satisfy the diversions sought to be enjoined herein. Further, all diversions in Wyoming existent when Wyoming became a state can be satisfied and yet leave more than sufficient water to supply the demands of Colorado presented herein. No question of disturbing rights which had vested prior to the erection of the two states is presented.

The doctrine of prior appropriation by reason of the necessities existing in the arid region prevailed at all times therein, furthermore, as far back as 1866 by federal legislation the existence of such doctrine was recognized to be applicable to the arid regions.

> "The Congress of the United States, appreciating that nearly one-half of the National Domain consists of arid lands which can be utilized for occupancy only by free use of waters from flowing streams, recognized this necessity for such use in numerous acts, commencing with the act of July 26, 1866, and including the Reclamation Act of June 17, 1902, and one or more subsequent acts. These acts are cited simply for the purpose of

showing the recognition by the legislative department of the Government of the conditions which made the arid portion of our country different from the humid portion and which required a wider scope for necessary natural uses than would be the case in a region of abundant rain fall.

This legislation has been held by this court not to be the creation of new rights among the people *inter sese* so much as a recognition of existing rights."

Broder vs. Water Co., 101 U. S., 274, 276.

U. S. vs. Rio Grande Irr. Co., 174 U. S., 690, 704.

Gutierres vs Albuquerque Land Co., 188 U. S., 545, 553.

The relation of the Federal Government to the waters of streams like the Laramie was that of sovereignty. This relation passed to the states upon their erection without any express legislation. The passage of such right to the states arose just like the doctrine of prior appropriation, that is, through the doctrine of necessity. The original thirteen states were the owners of the great natural resources. The new state, in its sovereign capacity, became the owner of such resources.

Martin vs. Waddell et al., 16 Peters, 367.

The original thirteen states were owners, in their sovereign capacities, of the waters of their rivers, navigable and non-navigable. As to the navigable streams, this ownership in their sovereign capacities was subject to the paramount right of control in the National Government over such streams for purposes of navigation, but subject to this paramount easement in the National Government, the ownership in their sovereign capacities was as absolute in navigable streams as in non-navigable streams.

"By the preceding course of reasoning we have arrived at these general conclusions: First, the shores of navigable waters and the soils under them were not granted by the Constitution to the United States, but were reserved to the States respectively. Secondly, the new States have the same rights, sovereignty, and jurisdiction over this subject as the original States."

Pollard's Lessee vs. Hagan et al., 3 Howard, 230, Decided in 1845.

"In like manner, the States own the tide waters themselves, and the fish in them, so far as they are capable of ownership while running. For this purpose the State

represents its people, and the ownership is that of the people in their united sovereignty."

McCready vs. Virginia, 94 U. S., 394.

"The title thus held is subject to the paramount right of navigation, the regulation of which, in respect to foreign and interstate commerce, has been granted to the United States. There has been, however, no such grant of power over the fisheries. These remain under the exclusive control of the State, which has consequently the right, in its discretion, to appropriate its tide waters and their beds to be used by its people as a common for taking and cultivating fish, so far as it may be done without obstructing navigation."

Ib.

"Upon the admission of California into the Union upon equal footing with the original States, absolute property in and dominion and sovereignty over, all soils under the tide waters within her limits passed to the State, with the consequent right to dispose of the title to any part of said soils in such manner as she might deem proper, subject only to the paramount right of navigation over the waters, so far as such navigation might be required by the necessities of commerce with foreign nations or among the several States, the regulation of which was vested in the General Government."

Weber vs. Harbor Commissioners, 18 Wall., 57, 65.

"California was admitted into the Union, September 9, 1850, and the act of Congress admitting her declares that she is so admitted on equal footing, in all respects, with the original States. The settled rules of law in this court is, that the shores of navigable waters and the soils under the same in the original States were not granted by the Constitution to the United States, but were reserved to the several States, and that the new States since admitted have the same rights, sovereignty and jurisdiction in that behalf as the original States possess within their respective borders.

When the Revolution took place the people of each State became themselves sovereign, and in that character hold the absolute right to all their navigable waters and the soils under them, subject only to the rights since surrendered by the Constitution.

Necessary conclusion is, that the ownership of the lot in question, when the State was admitted into the

Union, became vested in the State as the absolute owner, subject only to the paramount right of navigation."

Mumford vs. Wardwell, 6 Wall., 435, Decided in 1867.

"For when the Revolution took place, the people of each State became themselves the sovereign; and in that character hold the absolute right to all their navigable waters and the soils under them for their own common use, subject only to the rights since surrendered by the Constitution to the General Government."

Martin vs. Waddell, 16 Peters, 367, 411.

" 'The original States possessing this interest in the waters within their jurisdictional limits, the new States can not stand upon an equal footing with them as members of the Union, if the United States still retain over their navigable waters any other right than is necessary to the exercise of its constitutional powers.' "

Mobile vs. Eslava, 16 Peters, 253.

"The United States, then, may claim for the public an easement for transportation of merchandise, etc., in the navigable waters of the original States, while the right of property remains in the States."

Ib.

"If sovereign over navigable waters, is there any reason to say the States are not sovereign over the non-navigable waters? How did the States retain their right? They retained it by withholding it from the General Government."

Senator Teller.

"The right of Alabama and every other new State, to exercise all the powers of government, which belong to, and may be exercised by the original States of the Union, must be admitted, and remain unquestioned, except so far as they are temporarily deprived of control over the public lands."

Pollard's Lessee vs. Hagan, 3 How., 224.

See also Illinois Central Ry. Co. vs. Illinois, 146 U. S., 435.

In Martin vs. Waddell, 16 Pet., 367, it was held that, when the American Revolution was concluded,

> "the people of each state became themselves sovereign; and in that character hold the absolute right to all their navigable waters, and the soils under them, for their own common use, subject only to the rights since surrendered by the Constitution."

In Pollard vs. Hagan, 3 How., 212, it was held:

> "That the shores of navigable waters and the soils under them were not granted by the Constitution of the United States, but were reserved to the States respectively, and the new states had the same rights, sovereignty, and jurisdiction over the subject as the original States."

In the case of The Genesee Chief, 12 Howard, 443, it is said (in reference to the proprietorship of the bed and shores of the Great Lakes and other navigable waters, above as well as below the flow of the tide):

> "It properly belongs to the States by their inherent sovereignty, and the United States has wisely abstained from extending (if it could extend) its survey and grants beyond the limits of high water."

In Hardin vs. Jordan, 140 U. S., 371, it was held that:

> "Grants by the United States of its public lands bounded on streams and other waters, made without reservation or restriction, are to be construed, as to their effect, according to the law of the State in which the lands lie."

In the opinion, after stating that the title to the shore and lands under water is in the States and is regarded as incidental to its sovereignty, it is said:

> " 'The lands are subject to state regulation and control, under the condition, however, of not interfering with the regulations which may be made by Congress with regard to public navigation and commerce. * * * This right of the States to regulate and control the shores * * * is the same as that which is exercised by the crown in England.' "

The pith of this decision is that it is one of the sovereign rights of a State to own and control its waters, subject, how-

ever, to the superior control of the National Government for the purposes of navigation and commerce, the Federal Government being limited to certain excepted and enumerated powers, among which is the right to control all navigable streams for purposes of navigation and commerce.

In the Enabling Act it is recited:

> "Which state (Colorado), when formed, shall be admitted into the Union upon an equal footing with the original states in all respects whatever, as hereinafter provided."
>
> Enabling Act, 1 Mills Ann. Colo. Stats., —, c. 23.

The Constitution, made in pursuance of said Enabling Act, prescribes:

> "The water of every natural stream, not heretofore appropriated, within the State of Colorado, is hereby declared to be the property of the public, and the same is dedicated to the use of the people of the state, subject to appropriation as hereinafter provided."
>
> Article 16, Sec. 5, Colorado Constitution.

This was simply the declaration of sovereign ownership, common ownership for the people of the State at large.

The proclamation admitting the State provides:

> "And for the admission of such state into the Union on equal footing with the original states."

Colorado judicial construction and Colorado development have proceeded upon this theory of state ownership of the waters of the streams of the state.

The case of Stockman vs. Leddy, 55 Colo., 24, involved the validity of an appropriation by the state legislature for the protection of the rights of the state and its citizens in the natural streams of the state. The appropriation was held valid and that the General Assembly had the power and was charged with the duty of protecting the interests of the state in the natural streams. *Inter alia* the court said:

> "This constitution of ours was ratified and adopted by the legal voters of the state in accordance with the conditions prescribed by the enabling act of congress, and the president of the United States in his proclamation admitting Colorado into the Union found the fact to be that the fundamental conditions imposed by con-

gress on the State of Colorado to entitle it to such admission had been complied with. Congress, in passing the enabling act, and the President, in issuing his proclamation, were aware of the existing physicial conditions and of the topography and geography of the state. The federal government, by its lawmaking and executive bodies, knew that the natural streams of this state are, in fact, nonnavigable within its territorial limits, and practically all of them have their sources within its own boundaries, and that no stream of any importance whose source is without those boundaries, flows into or through this state. The entire volume of these streams is therefore made up of rains and snows that fall upon the surface of lands included within the exterior lines of this state and of springs which issue from the earth within the same area. Such being the peculiar conditions, the state was justified in asserting its ownership of all the natural streams within its boundaries. When Colorado was admitted into the Union with such a constitution, the federal government, through its lawmaking and executive departments, thereby recognized and confirmed such right of ownership as belonging to the state in its sovereign capacity. We therefore find it to be not only that our state constitution and pertinent statutes, but the decisions of the courts and duly announced public policy, all are in accord on the proposition to which the federal government has, as we have just shown, given its consent that the waters of the natural streams of this state belong to the people, to the state, in its sovereign capacity, and that its right to their distribution and control within its borders is free from any interference by any other sovereignty."

* * * * * * * *

"The right of congress to regulate and control navigable interstate streams and the jurisdiction of the Supreme Court of the United States to determine, in a controversy between two or more sovereign states over the waters of an interstate stream, whether they are reasonably exercising their inherent powers of sovereignty, are not overlooked or questioned by us; but these considerations do not, for the reasons above stated, affect or bear upon the right of ownership and control by Colorado of its own natural streams, and its power and authority to regulate the distribution of their waters, within its own territory, for beneficial purposes. We find nothing in United States v. Rio Grande Irrigation

Co., 174 U. S. 690, 19 Sup. Ct., 770, 43 L. Ed. 1136. Kansas v. Colorado, 206 U. S. 46, 27 Sup. Ct. 655, 51 L. Ed. 956, Rickey L. & C. Co. v. Miller & Lux, 218 U. S. 258, 31 Sup. Ct. 11, 54 L. Ed. 1032, Bean v. Morris, 221 U. S. 485, 31 Sup. Ct. 703, 55 L. Ed. 821, or in any other case that has been brought to our attention, which militates against our conclusion, when these cases are considered, as they should be, in connection with the facts on which they were determined. We therefore conclude that the general assembly, in order to protect the rights of the state in our natural streams and their waters, and the interests which its citizens have acquired thereunder, may make a valid appropriation of money for the purpose of protecting and defending them."

"The rights of riparian owners of land situated upon navigable rivers are to be measured by the rules and decisions of the courts of the state in which the land is situated, whether it be one of the original states or a state admitted after the adoption of the Constitution."

St. Anthony Falls W. P. C. v. St. Paul Water Commissioners, 168 U. S. 349.

Further, that the extent to which a sovereign state may insist upon this right rests largely with her.

In Hudson Water Co. vs. McCarter, 209 U. S. 349, 357, it is said:

"It finds itself in possession of what all admit to be a great public good, and what it has it may keep and give no one a reason for its will."

Observe also the significant language appearing elsewhere in the opinion of the court in this same case:

"But we agree with the New Jersey Courts, and think it quite beyond any rational view of riparian rights that an agreement, *of no matter what private owners*, could sanction the diversion of an important stream outside the boundaries of the state in which it flows. *The private right to appropriate* is subject not only to the rights of lower owners, but to the initial limitation that *it might not substantially diminish* one of the great foundations of public welfare and health." (Italics ours.)

And in Georgia vs. Tennessee Copper Co, 206 U. S. 230:

> "If any such demand is to be enforced, this must be notwithstanding the hesitation that we might feel if the suit were *between private parties*." (Italics ours.)

and in the same case:

> "Whether Georgia, by insisting upon this claim, is doing more harm than good to her own citizens, is for her to determine."

And in Hudson Water Co. vs. McCarter, supra, this language:

> "But it is recognized that the state, as quasi sovereign and representative of the interests of the public, has a standing in court to protect the atmosphere, the water and the forests within its territory irrespective of the assent or dissent of the private owners of the land most immediately concerned."

And observe this language:

> "But when the *state itself* is concerned and by its legislation expressly repudiates the rights set up, an entirely different question is presented."

August 25, 1902, when there was an abundance of water to satisfy all appropriations existent and initiated for the purpose of irrigating Wyoming lands, Colorado citizens initiated the appropriation rights which are sought to be enjoined in this proceeding.

A large section of the most fertile lands within the State of Colorado, to-wit, the lands embraced within the Greeley-Poudre Irrigation District, were lying arid and without the possibility of development without irrigation. They were located at a favorable altitude, were productive in character, and were contiguous to lands which had been developed by irrigation and which were among the most valuable and productive lands in the United States. All this area of 125,000 acres, most of which at that time was unoccupied Government land, required to be brought to a high state of fertility was the presence of water for irrigation purposes. The capacity of the immediate streams and watersheds for securing water was exhausted. The only source from which water could be secured to reclaim this land was to enter another watershed and tap the upper reaches of the Laramie River. This was the only practicable source of securing water. Engineers were employed, investigations were made, and the conclusion reached that it was practicable, at enormous cost, to reach these waters, gather and equalize

them in the reservoir known as the tunnel reservoir, shown on Defendants' Exhibit 1, drive a tunnel through the Green Mountains about two miles in length, deposit the waters in the Poudre River and thence convey them along the river and through artificial channels a distance of about 125 miles to the Greeley-Poudre District. Filings in aid of water rights were made, ditch and reservoir construction entered upon, and from that date to this, there has been a continuity of the struggles of these people to build and use this system. Fortunes have vanished, lives have been lost, but still the struggle has gone valiantly on. The undertaking was of a more stupendous character than its bold conceivers at first dreamed. Heavy construction work for gathering the waters to be precipitated into the tunnel was involved. The construction of a tunnel reservoir, the driving of a tunnel at a cost of more than half a million dollars and the various other steps detailed in the fuller discussion of this undertaking were made for the purpose of bringing it to a practical conclusion. Under the laws of Colorado, an irrigation district was formed of 125,000 acres in Weld County, bonds were voted amounting to $5,100,000 which constituted, as to their payment, a lien upon the lands of the district. Bonds of the par value of about $2,700,000 of this issue have gone into this construction. The bonds were issued in December, 1909, and work went vigorously on until the institution of this suit. After the institution of this suit in 1911, the sale of the bonds was materially impaired and further construction has proceeded according to the resources of the district, which have been limited.

The construction of this system is practicable. The construction of this system will be completed if Colorado prevails in this suit. If the system is completed, the water will be used for the reclamation of one of the most valuable districts of the west. If this system is not completed, which it will not be if this suit is lost, instead of the waters of the Laramie River being applied to the reclamation of valuable lands, they will be wasted, comparatively speaking, upon the arid lands of the Laramie Plains. If this water be applied upon the Laramie Plains, it will be applied to a district of country which has an altitude of about 7,000 feet, where the soil is indifferent, the growing season is short, being about 56 days, where the yield per acre under any system of agriculture or irrigation will be slight as compared with the production of the Poudre Valley, and will be confined to such crops as hay, alfalfa and crops which can be grown in a very short season. The hay yield, whether as to natural hay or alfalfa, will be small and far inferior in quantity to the yield in the Poudre Valley. If the water which is now used upon the Laramie Plains were economically used, it is ample to supply many times all the lands

there under cultivation, leaving unimpaired the threatened diversion for Colorado. The better portion of the Wyoming land lies in the Wheatland district. Water to supply all of this country can be furnished by the diversions from the Laramie River, Sybille and Chugwater Creeks and yet leave water sufficient to supply all reasonable needs of the Laramie Plains and also the Colorado diversions.

If this diversion be allowed to Colorado, it will go to land which can be watered from no other source; it will be applied upon land from which the highest returns that are practicable under irrigation will be secured; it will be applied to lands where every favorable condition exists. If this diversion be taken from Colorado, it will work no substantial benefit to Wyoming, where its non-productive lands are now sufficiently supplied with water and will, in effect, be wasting not only a great natural resource of the State of Colorado, but a great natural resource that will mean not only great beneficial results to the people of the State of Colorado, but great practical results indirectly to the people of the nation. To deprive Colorado of this natural resource is simply to annihilate, in a degree, the producing power of the lands of the country which is needed for the sustenance of its people.

The Wyoming priorities as they existed at the time of the initiation of the Colorado diversion, August 25, 1902, will be discussed exhaustively hereafter. The character of the Wyoming lands as to productiveness, the system of irrigation in Wyoming as it exists, the great loss in dead storage, the great loss in wasteful irrigation, will also be discussed hereinafter and all go to show that if Wyoming irrigators would economically use the waters that are going to them after the Colorado diversions, they would have no shortage in their supply.

To sum up the facts, the water which Colorado seeks to divert is a part of a great natural resource within the state. The conditions within this state are such as to render necessary this diversion for uses within Colorado. The necessity for this use cannot be supplied from any other source. It is the contention of Colorado that these waters belong to her in her sovereign capacity, that it is but a reasonable exercise of one of her rights of sovereignty to divert this water and apply it to her necessary uses within her limits; that in so doing she is exercising reasonably one of her rights of sovereignty, and in truth is working no practical damage to the State of Wyoming. On the other hand, to sustain this bill and sustain the contention of the State of Wyoming would be to give her practically all of the waters of an interstate stream, to take from the State of Colorado practically all of a great natural resource, to take from Colorado a portion of this resource which would be, in a large measure, wasted upon unproductive lands and even the loss of which

could be abundantly supplied by Wyoming reasonably and economically using that which she now has.

Were Wyoming to prevail in this suit, it would mean to take a great natural resource from her sister state and fasten upon her streams and her lands a servitude unreasonable in its prejudicial effects upon Colorado and wasteful in its beneficial effects to Wyoming. In fact, if this suit were to be dismissed, Colorado, by reason of natural conditions, could never divert more than a maximum of 91,000 acre feet annually from this stream, and if Wyoming would economically use the water remaining and eliminate her present wasteful use, she would save for beneficial use more water than is involved herein.

As stated in the inception, this case will turn upon no nice distinctions of fact. The facts which are in this record without substantial dispute, aided by facts of which the court takes judicial notice, will suffice as to fact to enable this court to rule this case. Take for example such subjects as the development of the Greeley-Poudre Irrigation system, its difficulties, its extent, its highly beneficial purposes, the productiveness of the Poudre Valley, the irrigation system of the Laramie River, its condition when the Greeley-Poudre diversions were initiated, its steps chronologically since, the altitude, the climatic conditions, the character of the soil, nonproductiveness of the Laramie Plains, the interwatershed diversions, national, international, interstate, intrastate, all deserve and will receive full discussion as this brief proceeds.

As to the subject of interwatershed diversions. The time has been in the history of jurisprudence when water in some jurisdictions was not permitted to go beyond the watershed, but the common law being interpreted consistently with natural conditions has, at all times, yielded in the West, through the arid states, to the necessities of natural conditions. So the riparian doctrine has adjusted itself to conditions where it obtained. In some jurisdictions the law has been interpreted as requiring the water to go by practically unabated, in other jurisdictions it has been construed as permitting a reasonable amount to be withheld for purposes of irrigation; further, that the amount so withheld should depend on the size of the stream, the necessities of the situation, and other like conditions.

Evans vs. Merriweather, 3 Scan., 492, 495.
Irrigation Co. vs. Vivian, 74 Tex., 170.

If waters were confined for the purposes of irrigation to the watershed of the stream, the beneficial results from irrigation would frequently be destroyed, because fertile fields of extent can frequently only be reached by entering another watershed. Such conditions have caused the common law to

yield or to make it rather adapt itself as the winds and the atmosphere adapt themselves to the undulations of the earth, to the varied conditions it may find. All of the arid states—Colorado, Wyoming—permit these diversions to another watershed. Instances will be shown where Wyomnig is carrying water to other watersheds throughout the state, in fact, where she is even now diverting water from Colorado to another watershed within her state. She is not in a condition to complain that Colorado, being entitled to avail herself of a part of this water as one of her resources, cannot carry it wherever her laws and her natural conditions permit.

DISCUSSION OF THE FACTS.

In detail, the facts lend themselves to several specific subjects. Some of these are intimately co-related. Primarily, there is the question of water supply, and, in connection therewith, it is pertinent to discuss the amount of land which a given quantity of water will adequately irrigate, in other words, the duty of water, and the total amount of land under irrigation from the Laramie River and its tributaries. Further, the question of the relative priorities of diversions from the Laramie River in the two states, particularly the more recent projects; the question of the methods of administration of water and the methods of use; the question of interwatershed diversions and the productive value of the Wyoming area in controversy compared with the Colorado area which the defendants seek to reclaim by water from the Laramie River, and, ultimately, the broad question of equity between the two sovereign states in view of all the circumstances involved.

In the discussion of these various subjects, we wish, primarily, to establish the facts as disclosed by the testimony and then to draw our conclusions therefrom.

THE WATER SUPPLY.

The complainant seeks to restrain the State of Colorado. The Greeley-Poudre Irrigation District and The Laramie-Poudre Reservoirs & Irrigation Company from diverting water through a tunnel from the Laramie River into the Poudre River for the irrigation of 125,000 acres of land included within the Greeley-Poudre Irrigation District and lying in the watershed of the Poudre River outside and to the east of the mountains.

The Greeley-Poudre Irrigation District is a municipal or quasi-municipal corporation, organized under a general law of the State of Colorado permitting the formation of districts whereby the lands included are burdened by a system of taxation for the purpose of securing water for irrigation. The law permits the election of officers for the management of the affairs of the district by the owners of the land residing within the district, and the right of the district to issue bonds in order to acquire, by purchase or construction, necessary irrigation works and water for irrigation.

The third defendant, The Laramie-Poudre Reservoirs & Irrigation Company, is, so far as the present status of the case is concerned, merely the construction company, occupying a contractual relationship with the Greeley-Poudre Irrigation District for the construction of the irrigation works, although, at the outset, the Laramie-Poudre Reservoirs & Irrigation Company and its predecessors in interest were the real parties in interest in the diversion of the water from the Laramie River. A more detailed description of this relationship will be given later.

The measurement of water in running streams is not an exact science; although definite methods have been adopted by hydrographers and definite machines employed, nevertheless, it will readily be seen that flowing water, particularly in a swift current, does not lend itself to absolute accuracy of measurement. This is particularly true if it is sought to establish the normal flow of a stream from measurements or a series of measurements limited to one or two years or fractions of years. However, when records covering a number of years are known, it is possible to arrive at a fairly accurate determination of the normal flow of the stream. It will, of course, be recognized that any test of the amount of water flowing in the Laramie River must be based upon what appears to be the normal flow rather than upon the flow for any one particular year, inasmuch as the proposed diversion which is sought to be restrained will, unless enjoined, constitute a continuing diversion.

The Poudre River cannot supply the water necessary for the irrigation of the lands of the Greeley-Poudre District. This is almost self-evident when it is recalled that the defendants have gone to an enormous expense in the construction of a monumental engineering work, that is, the tunnel and collection ditches, in order to divert water from the Laramie into the Poudre, and also that other companies have similar works, notably, The Water Supply & Storage Company, operating in the Poudre Valley, has already constructed, at enormous expense, three interwatershed diversion ditches, one bringing water from the upper reaches of the Grand River across the Continental Divide into the Poudre, another bringing water

from the Michigan, a tributary of the North Platte, and the third bringing water from the Laramie River through the Sky Line canal into the Poudre; that another mutual irrigation company, The Mountain Supply Ditch Company, now merged into The North Poudre Irrigation Company, brings water from the Michigan, a tributary of the North Platte, into the Poudre, and the Divide Canal Company (Wilson Supply Ditch) diverts water from the upper reaches of Deadman, a tributary to the Laramie, into Sand Creek, thence into a tributary of the Poudre. In this cause none of these diversions other than the Greeley-Poudre project is attacked.

It is, however, proper to review the evidence as to the water supply in the Poudre and the demands thereon for irrigation in order to show, beyond a doubt, that there is not sufficient water in that stream for the irrigation of the Greeley-Poudre District.

Water Supply, Poudre River.

The evidence, as a whole, discloses that the Poudre Valley watered by irrigation from the Poudre River is an area of high agricultural development. This has been made possible solely by irrigation, and in this valley is probably found the highest development of irrigation in the United States. The demand for the necessary water for the irrigation of lands under the ditches has been so great that the result is a system whereby the administration of water has received scientific study and treatment. The administration of the officials of the state whose duty it is to police the streams and apportion the water to the various ditches is constant and definite. The methods of exchange whereby a ditch heading on the river in the upper portion of the area stores flood waters, which, during the irrigation season it releases for the use of an older ditch further down the river, and in turn takes the water otherwise unavailable, to which the older ditch would be entitled; the methods of exchange between reservoirs and the general community of interest in the valley show to anyone familiar with the situation that the area under primitive methods was short of water years ago and that a higher development and a greater reclamation of the lands within the valley has been accomplished because the need of water brought about better methods.

The evidence discloses that other ditches for projects other than the Greeley-Poudre project have been undertaken, with a view to and with the effect of enlarging the amount of water available in the Poudre River for the irrigation of this area.

The Water Supply & Storage Company, as has been definitely shown in the discussion of the subject of interwatershed diversions, built, not one, but three, ditches for the purpose of bringing water across the Continental Divide into the Poudre

River. Of these the third to be constructed was the Sky Line Ditch, diverting water from the Laramie River. It was commenced in 1891 and required three years to construct, although it is only five miles in length (2206). These ditches were constructed because the supply from the Poudre River was not sufficient for the needs of the water users under the main canal of the company known as the Larimer County Ditch (2205, 2213-2214).

The Mountain Supply Ditch Company built one, now belonging to the North Poudre Irrigation Company, and the Divide Canal Company built another.

It is obvious that the ditches and engineering works by which these interwatershed diversions were accomplished are of extraordinary cost. The expense is enormous. These four diversions were made at a date far earlier than the inception of the Greeley-Poudre project and have entailed the expenditure of probably hundreds of thousands of dollars, and when it is considered that the ordinary diversion and distribution systems from the Poudre River for the irrigation of the lands in the Poudre Valley have to be constructed and maintained in addition to these interwatershed diversion ditches in the mountains, in order that the water which is dropped into the Poudre River near the crest of the continent may be, at the proper place, taken from the river and applied to the land, there would seem to be no argument that the Poudre Valley was not short of water for the area already under irrigation exclusive of the Greeley-Poudre Irrigation District before the commencement of that later project. To argue otherwise would be to say that the users of water in the Poudre Valley had lost their senses and had spent vast sums of money for the construction of needless ditches.

Professor L. G. Carpenter made an investigation of the water supply available for the Greeley-Poudre Irrigation District in 1909 and 1910. That was before the filing of this suit. He made a report on this project, portions of which were introduced in evidence by the complainant in the course of the cross-examination of Professor Carpenter and a portion of this report is quoted in the testimony (3933), but in order that this report may be correctly understood, it must be borne in mind that the Greeley-Poudre system contemplates the construction of at least one large reservoir in the channel of the Poudre River in order that the peak flow of the flood waters which cannot be profitably intercepted by any ditch might be impounded. This plan is discussed elsewhere in the brief. Professor Carpenter, in his report, estimated that there was available in the Poudre River an average of 120,000 acre feet, but that this 120,000 acre feet cannot be diverted by the proposed system because of inability of the ditches to carry the full

amount of water which might be available for a very short length of time, but that the channel reservoir planned will be of material assistance and will lead to much better development of the system through exchange and through its ability to intercept the flood waters, and that in this way from 60,000 to 90,000 acre feet of Poudre water might become available for the use of the district within a few years (3936).

The total available water for the Greeley-Poudre District, according to Professor Carpenter's estimate in 1910, is summed up as follows: From the Laramie River, 70,100 acre feet; from the Poudre River, 60,000 and 90,000 acre feet; from Dowdy Lakes, that being a system of lakes lying in the mountains on the Poudre side which form part of the reservoir system of the district, 2,990 acre feet; from Douglas Reservoir, which is a reservoir already existing and in which the Greeley-Poudre district has an interest, 5,833 acre feet, and from flood waters of Lone Tree and Crow Creeks, from 3,000 to 10,000 acre feet, making a total of from 142,000 to 179,000 acre feet (3936).

It must be remembered that the 70,100 acre feet which the witness estimated to be available from the Laramie is measured at the tunnel and from that point it is subject to the loss by seepage and evaporation as it flows down through the canyon of the Poudre River to the headgate of the diversion ditch and to the loss by seepage and evaporation as it flows through the miles intervening between the headgate of the ditch and the lands of the district, and that all water from the Poudre River is likewise subject to the loss in transit from the head of the same ditch to the point of application.

The witness John R. Wortham, engineer for the Greeley-Poudre District, testified that the whole water supply obtainable from the several sources was necessary for the irrigation from year to year of the land within the Greeley-Poudre District (1708).

Under the law of the State of Colorado the Poudre River is subject to a demand for water when necessary to supply prior appropriations on the South Platte River below the mouth of the Poudre. That is to say, if the flow in the South Platte River below the mouth of the Poudre is not sufficient to supply the demands in that district, then the Poudre River must supply, in proportionate share with other tributary streams of the South Platte River, a sufficient quantity of water to furnish prior appropriations below. Accordingly, a junior appropriator on the Poudre may be compelled to relinquish his right to obtain water although it is available in the Poudre River, if it is necessary to supply an earlier appropriation on the South Platte. For this reason it sometimes happens that late appropriations on the Poudre are denied water because of a shortage on the main stream, so that in arriving at an estimate

of the quantity of water available from the Poudre River it is not possible to consider alone the normal flow of the Poudre River and the needs of the 300,000 acres of land irrigated in the Poudre Valley. The relationship of appropriators of water in Water District No. 3 of the State of Colorado, that is, the Poudre Valley, to the appropriators on the South Platte River below the mouth of the Poudre, must be considered. (3411.)

The normal yearly flow in the Poudre River, based upon a record of thirty years, is, according to Exhibit 123, 315,896 acre feet, measured at the mouth of the Poudre canyon, but in order to arrive at the normal flow of the Poudre River itself, there must be deducted from the amount measured at this point the amount of inflow from interwatershed diversions entering the Poudre, and there must be added the amount which is diverted by ditches above the gauging station, these being shown by Exhibit 124, and in order to get the total supply of the Poudre River, there must also be added inflow from some small tributary streams having some flood water flow, below the gauging station, making the average water supply of the Poudre River, in round numbers, 367,000 acre feet per annum (3410-3411).

A conclusion, therefore, based alone upon the fact that there is an annual water supply of 367,000 acre feet on the Poudre River, and that there is now under irrigation in the Poudre Valley, as will be shown later, exclusive of the lands in the Greeley-Poudre District, approximately 300,000 acres, and that the duty of water, measured at the land, including the use of the original and available seepage and return waters, is approximately one acre foot per acre, does not necessarily mean that the Poudre Valley allows 67,000 acre feet per annum to go to waste, and, even if it did, and assuming that this 67,000 acre feet per annum was available for the use of the Greeley-Poudre Irrigation District, nevertheless it alone would not be sufficient for the irrigation of the Greeley-Poudre District, which contains 125,000 acres.

Exhibits 123 and 124 were prepared by State Engineer John E. Field, based upon records in the office of the State Engineer, and the conclusion of the total water supply of 367,000 acre feet per annum on the Poudre is likewise Mr. Field's conclusion. Assuming 300,000 acre feet per annum necessary for the irrigation of the 300,000 acres of land in the Poudre Valley and assuming also that there will never be a demand on the Poudre for water for the South Platte, we then have 67,000 acre feet available for the use of the Greeley-Poudre District if it be possible to intercept it. It is noticeable that this corroborates Professor Carpenter's estimate that there is from 60,000 to 90,000 acre feet available. It probably shows also that Mr. Field, the State Engineer, was conservative in

his estimates. However that may be, the duty of water as established for the Poudre Valley as approximately one acre foot per acre prevails as the water is applied to the land, not according to measurement made at the head of the ditch. There is of necessity considerable loss in transit and we do not contend that one acre foot is the duty of water in the Poudre Valley measured at the headgate. However, it is significant that inasmuch as there seems to be an average of about 110,000 acre feet per annum, including original and seepage waters, passing out of the Poudre into the Platte (3411) of which probably fifty per cent is seepage water (see Exhibit 113 and testimony of John L. Armstrong, Water Commissioner, pages 2487-2498) and the balance original water, that the loss in transit in the ditches is almost exactly offset by the re-use or, in other words, the use of the seepage water available in the valley.

Witness Armstrong, who has been Water Commissioner of the District included in the Poudre Valley for a great many years and is thoroughly familiar with the supply and the demands, also testifies that the Greeley-Poudre Irrigation District could not depend for irrigation upon surplus water available from the Poudre River alone, and that in order to irrigate these lands it would be necessary to supplement the available Poudre Valley supply by water from the Laramie River (2494).

The primary need of the Poudre Valley, according to Charles R. Hedke, at one time an engineer for The Laramie Poudre Company, is and will be for all time in the future, the problem of securing water for its lands still unreclaimed (1735-1739).

Water Supply, Laramie River.

In discussing the question of the water supply of the Laramie River, it is necessary to understand something of the geography and topography of the watershed. As already stated, the stream has two branches which are particularly involved in this cause, the main branch commonly called the Laramie River and sometimes referred to as the Big Laramie, heads in Colorado; the other branch, called the Little Laramie, is entirely within the State of Wyoming. These two unite at a distance of approxmately twenty miles below the City of Laramie. The Big Laramie arises about twenty-seven miles in an air line south of the Wyoming-Colorado line, and during its entire course in the State of Colorado, flows in a general northerly direction through a narrow mountain valley at a very high altitude. This valley lies between two ranges of mountains forming the divides on the west between the Laramie River and the tributaries of the North Platte, and on the east between

the Laramie and the tributaries of the Poudre. By actual measurement, the amount of land irrigated in the Laramie Valley in Colorado from this river and its tributaries is 4,250 acres (Ex. 130). The agriculture in this area is confined to the production of native hay. These irrigated lands are a thread along the river and at no point is the water diverted any considerable distance from the channel. The ditches by which this diversion is made comply with the law of Colorado and have received decrees adjudicating their rights. They are not attacked in this proceeding.

The consumptive use of this water is slight, owing to the topography of the country and the proximity of the application to the stream (3460), and in the conclusions made by the hydrographers for both complainant and defendants, no charge is made against the flow of the stream for this use. In other words, this use is not considered in the determination of the flow of the stream, and may be eliminated. The same condition is true both as to the general character of the country, the kind and character of the agriculture and the application of water and also as to the charge against the flow of the stream, on the upper reaches of the Little Laramie River, generally referred to as the Centennial Valley. In other words, on both streams in both states the consumptive use for irrigation in the mountain regions near the sources of the streams has been eliminated from consideration in so far as the measurements of the two streams are concerned, and the measurements have been taken and considered as though no such diversions existed.

Returning now to the Laramie River, at a point about nine miles north of the Wyoming-Colorado line, the river emerges from the mountain valley and enters the Laramie Plains. From this point the mountain ranges or divides referred to diverge, forming the Laramie Plains, a high mountain plateau surrounded on three sides by mountain ranges. At this point also irrigation in a material way commences, everything above this point being of the character described.

In this Laramie Plains area there are a number of old ditches diverting water both from the Big Laramie and the Little Laramie, the largest of which is the Pioneer Canal, dating from 1879, most of the irrigation, however, being above the junction of the two streams. Below the junction, the river continues its northerly flow for a distance in an air line of about thirty miles and then, for the first time in its course, cuts through a mountain range, flowing in a northeasterly direction until it reaches the North Platte at the site of the historical post known as Fort Laramie. Fort Laramie and Laramie City are to be distinguished. After the river passes through this mountain range and enters the plains country, it traverses the northerly

edge of an agricultural district generally known as the Wheatland District.

The average elevation of the Laramie Plains is about 7,000 feet, while the average elevation of the Wheatland area is about 4,700 feet above sea level.

The natural conditions divide the irrigated districts on this watershed into that inside of the mountains on the Laramie Plains and that on the outside, the Wheatland area.

The controversy here does not so much involve these older ditches on the Laramie Plains above mentioned as it does some newer projects, and in this connection it is necessary to keep in mind three reservoirs which have a material bearing upon the question, these reservoirs being of great capacity, two of them at any rate being far above the average capacity of reservoirs and many times larger than any reservoirs in the Poudre Valley. The first of these is Lake Hattie, a material factor in the project of the Laramie Water Company. Its intake from the river is an enlargement of the upper portion of the Pioneer Canal. It has a total capacity, according to the testimony of Lyman E. Bishop, an engineer employed in its construction, who testified in behalf of the State of Wyoming, of 110,500 acre feet, of which amount 68,500 is available to be withdrawn from the reservoir, while 42,000 acre feet is dead water which cannot be withdrawn under the present circumstances, but which could be withdrawn, at least in part, by the construction of a cut between two natural basins upon which the reservoir is constructed (786, 787). Lake Hattie also has an intake from the Little Laramie River.

The next reservoir is Lake James, the source of supply of which is the Little Laramie River, Four Mile, Seven Mile and Mill Creeks, the last three being small creeks. Lake James has a capacity, according to Wyoming testimony, of 41,100 acre feet (632).

The third reservoir is the Wheatland Reservoir No. 2, usually referred to as the Wheatland Reservoir. This reservoir is located on the Laramie Plains, just above the canyon in which the river passes through the mountains. It is to be distinguished from Wheatland Reservoir No. 1, which is a smaller reservoir located near the center of the Wheatland tract. This Wheatland Reservoir No. 2, or Wheatland Reservoir, is what is termed a channel reservoir, that is to say, it is formed by the construction of a dam across the channel of the river and is of material significance on this account as will be shown later. It is very large, having a capacity of 126,000 acre feet according to the testimony introduced by the State of Wyoming, the witness being M. R. Johnson, for many years the manager of the company owning the Wheatland system, he testifying to that capacity as determined by a survey made under his supervision

(6, 60). This also appears to be the capacity shown by the filings made in the office of the State Engineer of Wyoming, although the complainant later, over the objection of defendants, attempted to contradict this testimony by its witness R. I. Meeker, an engineer and hydrographer employed by The Laramie Water Company, the owner of Lake Hattie, it appearing from the testimony that a controversy had heretofore existed between the Lake Hattie people and the Wheatland Company relative to the capacity of the Wheatland Reservoir. Meeker's testimony places the capacity of this reservoir at 83,400 acre feet (4309).

A glance at the map, Exhibit 1, attached to the answer of the defendants, The Greeley-Poudre Irrigation District and The Laramie-Poudre Reservoirs & Irrigation Company, will show that the Laramie River throughout its course in Colorado and through the Laramie Plains, flows parallel to and between the two ranges of mountains before mentioned, the enlarged valley between these two ranges constituting the Laramie Plains. The range on the west side of the river is known as the Medicine Bow Range, although in Wyoming at the head of the Little Laramie River the mountains are frequently termed the Centennial Mountains. The range on the east is known in Colorado as the Green Mountains and in Wyoming as the Laramie Mountains and the Black Hills. It is also to be noticed that throughout this portion of the watershed, the greatest inflow, as indicated by the tributary streams, is from the west, that is, from the Medicine Bow Range. The largest of these tributaries is the Little Laramie River.

It is the contention of Wyoming that their water supply from this range is inferior to that of Colorado, and inasmuch as Colorado will divert water from the main stream by means of the Greeley-Poudre tunnel, they will have an insufficient quantity of water. Later we will have occasion to show the relatively small proportion of the flow of the stream in Colorado which can be taken through the tunnel and the relatively small area of the drainage which will contribute to that supply.

In order to meet this contention and also to supplement measurements of the stream flow, measurements of the depth of the snow along this divide to the west, that is, the Medicine Bow Mountains, were taken. This was, because of the nature of country, a very perilous undertaking. A very graphic representation of the snow conditions along this divide is made through a number of photographs introduced by the defendants herein (Ex. 156). It is impossible to describe the snow conditions as adequately as these pictures show them. We therefore earnestly urge an inspection of this exhibit. There are some thirty photographs in the exhibit, with a legend giving the date upon which each picture was taken and the location of the

scene. These pictures were taken under the supervision of Professor L. G. Carpenter, an engineer of known ability, in order to supplement his investigation of the supply of water through stream measurements. In making these snow measurements, two hundred or more observations of the depth of the snow were taken and the quantity of water determined by measurements from time to time (3823).

The two ranges above mentioned converge at the head waters of the Laramie. In that vicinity the highest peaks in the mountain sheds contributing to the Laramie River are situated, but the Medicine Bow Range is narrower in Colorado than it is in Wyoming, so that while Colorado has possibly a higher average elevation for the range, that is in a measure offset by the greater breadth of the watershed in Wyoming. The lowest portion of the range is apparently near the line between the two states, the elevation decreasing from the head waters of the Laramie northward to this lower portion and then increasing again toward the area at the head waters of the Little Laramie where the elevation is again very high, Medicine Bow Peak, sometimes called Centennial Peak, having an altitude in excess of 12,000 feet, whereas the highest peak in the Colorado watershed is Clark's Peak with an elevation slightly in excess of 13,000 feet (3816-3823). The conclusion is irresistible that no marked difference exists in the precipitation along this divide between the Colorado area and the Wyoming area.

The range of mountains to the east of the Laramie River is not as high as the range to the west and there is much less precipitation and consequently less run-off from it, although one tributary of the river (Sand Creek) which is of considerable importance to this cause arises on this range in Colorado and flows almost due north into Wyoming, joining the Laramie River about nine miles above the City of Laramie. There are also tributaries to the river from the watershed on the east side of this range, these tributaries all converging near Wheatland, Wyoming. The principal ones are the North Laramie, the Sybille and the Chugwater. It is to be noted that all of the water of these three streams and also that of the Little Laramie and various other small tributaries of the river originate within the territorial limits of the State of Wyoming.

The total drainage area of the Laramie River and its tributaries, as has been stated, is 4,076 square miles, and of this a total of 393 square miles is in Colorado, 312 being in the drainage area above the state line on the Laramie River itself and 81 on Sand Creek.

The complainant, in connection with the testimony of its hydrographer, Mr. R. I. Meeker, introduced in evidence Exhibit C, being a small map indicating various points upon the stream and some of its tributaries at which gauging stations

for measurements were made. It is noticeable, however, that these gauging stations so indicated are for the year 1912 only and the exhibit in no wise indicates all of the stations which have been maintained in other years. As a matter of fact, it will be observed later that the Wyoming hydrographer bases his conclusions as to the normal flow of the stream almost completely upon measurements taken during a portion of the years 1912 and 1913 (on rebuttal modified by some measurements made in 1914), whereas the conclusions reached by the Colorado experts are based upon an analysis of the measurements made through a very much longer period.

In order that the court may understand the geographic location of the various stations, it is well at this time to describe the locations where measurements have been taken and testified to. Measurements have been made of the diversions through the Sky Line Canal and the Wilson Supply or Divide Canal; then upon the river itself, the highest station on the stream is at the Lanning Bridge, a short distance below the Greeley-Poudre tunnel; next at Glendevey, some nine miles below the tunnel; at Decker's Ranch, immediately above the Colorado-Wyoming line, and then at Boswells, immediately at the state line, these last two stations being only about a mile apart. Measurements were also made on various tributary streams in Colorado. Then in Wyoming measurements were made for a number of years at Woods Landing, which is the point above referred to where the river emerges from the mountains on to the Laramie Plains. Mr. Meeker, the Wyoming hydrographer, also took measurements, as shown by his exhibits and his testimony, at the head of the Pioneer canal, about four or five miles below Woods Landing. This is termed the Pioneer Dam. Measurements were also made upon the Big Laramie immediately above the junction of the Big and Little Laramies at a point called Two Rivers.

Passing now to the Little Laramie, measurements were taken at several places near the point where the stream emerges from the mountains on to the plains area, these being Filmore or Wright's Ranch, Hatton and May's Ranch. Mr. Meeker took measurements in 1912 and 1913 at the head of the Lake Hattie inlet from the Little Laramie, commonly referred to as No. 2 dam, but which is to be distinguished from the dam of the Wheatland Reservoir No. 2, and measurements were also taken on the Little Laramie immediately above its junction with the Big Laramie, this point also being termed Two Rivers. Another station maintained by Mr. Meeker and possibly others was immediately above the Wheatland Reservoir. This station is usually termed Lookout, although at times referred to as the Steel Bridge. Measurements have also been taken and are referred to at McGill, which is a short distance below the

Wheatland Reservoir but above the canon of the river, also at Wheeler's Bridge, which is below the canon. Measurements were also taken on Sybille Creek, on Chugwater and on the main stream at Uva, that being below all tributary streams except the Chugwater.

These measurements were not all taken by the same authority, nor at the same times, but, generally speaking, four authorities either co-operated or made separate measurements, they being the United States Geological Survey, the State of Wyoming, the State of Colorado, and The Laramie Water Company, through the hydrographer mentioned, Mr. Meeker.

Four witnesses testified to the flow of water in the Laramie River; one for Wyoming, Mr. R. I. Meeker, hydrographer for The Laramie Water Company, and three for Colorado, Mr. John E. Field, State Engineer of Colorado, Professor L. G. Carpenter and Mr. Charles R. Hedke.

One very important question is the amount of water supplied to the Laramie River by the State of Colorado, not alone the water flowing in the main stream at the state line, but also that contributed by tributary streams arising within the State of Colorado.

It is not advisable at this time to attempt any comparison of ability between witnesses for Colorado and the witness for Wyoming on this question. We will concede that Mr. Meeker was painstaking and conscientious. As stated before, however, his conclusions are based almost wholly upon measurements made during the years 1912 and 1913, as shown by his exhibits. On the other hand, Professor Carpenter, who is a recognized authority on matters of irrigation in the western states, bases his conclusions upon measurements made through a series of years by the State of Colorado, State of Wyoming and the United States Geological Survey, supplemented by measurements made by himself personally or under his immediate supervision, together with his general investigation of the whole country tributary to the Laramie River, including the snow measurements before mentioned. Mr. Field, as the evidence discloses, had had a wide experience as an irrigation engineer; had made investigations of the Laramie River in behalf of the United States Reclamation Service, with which bureau he had at one time been identified, and, as State Engineer of Colorado, had occasion to supervise measurements made in behalf of the state. His conclusions are reached after a complete analysis of all records at the various stations mentioned in the testimony. Mr. Hedke, as engineer for The Laramie-Poudre Reservoirs & Irrigation Company, had not only co-operated with Professor Carpenter to some extent, but had made an independent investigation of the water supply of the Laramie River

and the amount available through the tunnel for the Greeley-Poudre District.

It is conceded by the State of Colorado that the average annual diversion from the Laramie River by the Sky Line Ditch will probably amount to 16,000 acre feet per annum, while the average annual diversion by the Wilson Supply or Divide Canal will be about 4,000 acre feet per annum, making an aggregate of 20,000 acre feet as the average annual amount of water now diverted from the Laramie River by means of these two interwatershed diversion systems, and in determining the average annual flow of water from the Colorado area, this amount, 20,000 acre feet, must be taken into consideration. Some of the estimates of the flow at the state line include, while others exclude this amount.

Professor Carpenter testifies that the average run-off from the Colorado area, excluding the 20,000 acre feet through the Sky Line and Divide Ditches, is in excess of 300,000 acre feet per annum (3956). Adding to his estimated flow the Sky Line and Divide diversions, we have therefore a gross amount in excess of 320,000 acre feet per annum.

Mr. Hedke testified that, according to his investigation, there was an average amount of 70,000 acre feet available through the Greeley-Poudre system at the tunnel, that being about one-fourth of the total flow of the river at the state line (1823, 1852). Therefore his estimate is 280,000 acre feet net at the state line, excluding the Sky Line and Divide diversions, or a total of 300,000 acre feet.

Mr. Field, after making a thorough analysis of all records and measurements of the Laramie River, including the measurements made by the State of Colorado, the State of Wyoming, the United States Geological Survvey, measurements made by Professor Carpenter and certain unpublished records furnished by the State Engineer of Wyoming and others furnished by Mr. Meeker during the course of his cross-examination, reaches what he testifies to be a very conservative conclusion that the average flow at the state line, including the Sky Line and Divide diversions, will exceed 250,000 acre feet per annum (3477).

The complainant attempted no conclusion of this question until the introduction of its evidence in rebuttal, whereupon Mr. Meeker, as a summation of his evidence in this regard, estimates the average annual run-off at Woods Landing to be 200,000 acre feet per annum (4296). While Woods Landing is some nine miles north of the state line, and the flow at that point includes some Wyoming water entering the stream below the state line, nevertheless Mr. Meeker made no allowance whatsoever for any flow from Colorado into Wyoming through the

tributary stream Sand Creek, which is estimated by Mr. Field to be 17,000 acre feet per annum, and which probably more than offsets the Wyoming water entering the stream between the state line and Woods Landing. An analysis of Mr. Meeker's evidence discloses that this amount, 200,000 acre feet, is the net amount after deducting the Sky Line and Divide diversions. He did not testify to the amount of the Sky Line and Divide diversions, so, accepting the defendants' evidence upon this point, it means that Meeker's estimate of the Colorado run-off is approximately 220,000 acre feet per annum.

For the sake of clarity, let us tabulate the testimony of these four witnesses, showing the average gross amount of the annual flow at the Colorado-Wyoming line:

Professor Carpenter	320,000 acre feet
Charles R. Hedke	300,000 acre feet
John E. Field	250,000 acre feet
R. I. Meeker	220,000 acre feet

The methods by which these conclusions were reached are based upon so many and varied measurements and engineering calculations that we recognize a decided difficulty in making a brief statement that will fully explain them all. Probably nothing short of an anaysis of the evidence would suffice to make clear the processes by which the conclusions were reached, and we fear that the matter is so technical that it is rather a subject for the labor of a hydrographer than for a lawyer. Probably the conclusions themselves will, after all, be the most valuable to the court in determining the facts. However, we will attempt a brief review of the evidence, taking first the evidence of Mr. Meeker, who testified in this behalf for Wyoming.

Early in the presentation of the evidence in behalf of complainant, Mr. Meeker testified and produced a table introduced as Exhibit B, purporting to give the run-off of the Laramie River at the Pioneer Dam, which, as heretofore stated, is a short distance below Woods Landing. Mr. Meeker, according to his own testimony, while he had had considerable experience in hydrographic matters prior to his employment by the Laramie Water Company, had nevertheless been engaged in hydrographic investigation on the Laramie River only since May, 1912 (218). He testified the first time on August 22, 1913, so that his experience and observations on the Laramie River were limited to the period between those dates. His Exhibit B purports to show the run-off at the point indicated, based upon measurements made by himself from April to December, inclusive, 1912, and from January to August 18, 1913. While there were many records in existence of the flow of the

Laramie River at the time Mr. Meeker commenced his measurements, taken in some instances by the United States Geological Survey and in others by the State of Wyoming through the State Engineer's department and by the State of Colorado through its State Engineer's department, nevertheless Mr. Meeker did not see fit to include them in his table. He seems to have had either a lack of confidence in the measurements made by other hydrographers or a desire to discard them for the possible reason that they show a greater discharge than he found, but, at the same time, he evinces supreme confidence in his own measurements, although his confidence was possibly shaken before the conclusion of the testimony, judging from the number of errors which he admitted and the number of changes which he made. According to his table, Exhibit B, he found that the discharge of the Laramie River from April to December, 1912, amounted to 198,867 acre feet, and from January to August, 1913, 95,682 acre feet, these measurements being shown for the respective months covered. From these he endeavored to establish a mean, although such a mean must have been based upon one record for the months of September, October, November and December, 1912, and the months of January, February and March, 1913, and for the months of April, May, June, July and August, his mean is based upon the records for the two years. His total mean discharge for the year was then given at 160,498 acre feet. This is obviously too limited a period from which to establish a mean which would represent the average discharge of the stream. This is particularly true in view of the admitted fact that the year 1913 was one of extremely low precipitation and the run-off of the streams correspondingly low:

On this same table Mr. Meeker makes an estimate of the total flow for 1912, based upon the records for that year for the months designated and an estimate of the flow for the months not measured, in the total amount of 207,000 acre feet, and he seeks to show the distribution of that water from the point of measurement as follows: To the Pioneer Canal, 17,703 acre feet; into Lake Hattie Reservoir, 69,855 acre feet, and by referring to another table produced by the same witness, Exhibit K, we learn that the Lake Hattie commenced storing on April 8, 1912, and continued until October 5, 1912. Apparently they again recommended, because he notes that they ceased a second time on December 26, 1912. It is noticeable that water was being stored during the entire irrigation season. He then finds that there was distributed to all the ditches between the Pioneer Dam, the point of his measurements, and Two Rivers, the junction of the Big and Little Laramies, the further sum of 29,892 acre feet, and that there was distributed to the Wheatland Reservoir and any ditches diverting water between Two Rivers

and the Wheatland Reservoir, 89,550 acre feet, making up his total of 207,600 acre feet, and thereby balancing with the estimated flow at Pioneer Dam. It is noticeable that inasmuch as there are three or possibly four ditches diverting water between Two Rivers and the Wheatland Reservoir, only one of which is of any considerable size, and assuming the correctness of Mr. Meeker's figures, probably the greater portion of this 89,550 acre feet which he distributes to the intermediate ditches below Two Rivers, to the Wheatland Reservoir, found its way into Wheatland Reservoir. This, of course, does not include any other water than that flowing in the Big Laramie as counterdistinguished from the Little Laramie and other tributary streams below the Pioneer Dam.

For the year 1913, Mr. Meeker does not attempt an estimate for the full year, but confines himself to a statement limited to the amount shown by his measurements for that year, that is, 95,682 acre feet, which he distributes as follows, for that period: Pioneer Canal, 10,983 acre feet; Lake Hattie Reservoir, 28,470 acre feet. Referring again to Exhibit K, we find that the storage commenced from the Big Laramie in this reservoir April 25, 1913, and ceased on June 13, 1913. Following the same plan for showing distribution, he charges to all the ditches between the Pioneer Dam and Two Rivers, 18,167 acre feet, and to Wheatland Reservoir and intermediate ditches below Two Rivers, the sum of 38,062 acre feet. It is to be remembered that this table, Exhibit B, and the foregoing figures refer to water from the Big Laramie River only.

At a later date, November 13, 1913, and before the complainant rested its case, Mr. Meeker produced a second table similar to Exhibit B, introduced as Exhibit I (1035), which continues his measurements for the year 1913 to and including the 15th of November, increasing, however, two of his former monthly discharge records, Exhibit B, giving a discharge for July, 1913, of 6,764 acre feet while on Exhibit I he gives it as 6,825 acre feet, and for August, 1913, Exhibit B gives 3,038 acre feet while Exhibit I gives it 3,130 acre feet. He maintains his estimate of the flow and the distribution for the year 1912 as given before, but modifies his 1913 distribution to meet the enlarged flow coming from his longer record, and at the same time, endeavors to strike a mean based still upon his experience for a portion of the two years, 1912 and 1913, but with the enlarged experience of additional measurements for September, October and November, 1913. In this connection it is noticeable that inasmuch as 1913 showed a flow very much less than 1912, he reduces his mean from 160,498 to 158,206 acre feet.

Let us merely call attention at this time to the fact that Mr. Meeker, testifying in rebuttal, later modified this table a

third time, Exhibit T-7, and then was compelled, upon cross-examination, to correct it again (4322). This will be considered later.

He adopted the same method of treatment for the Little Laramie River, Exhibit J, establishing a mean upon records for the months of June to December, inclusive, 1912, and January to November, inclusive, 1913. In this table he finds the mean to be 68,727 acre feet. The measurements were made at the head of Lake Hattie Supply Canal No. 2 dam, that being a short distance below the station known as Filmore but below the diversion made through the Bellamy Canal, the intake to Lake James Reservoir, and also below the Loback canal. In this exhibit he estimates the total run-off for the year, 1912, at No. 2 dam, including the amount diverted by the Bellamy canal but excluding the Loback canal, to be 93,667 acre feet, which he distributes as follows: Bellamy Canal and James Lake Reservoir, 24,793; Lake Hattie Supply Canal No. 2, that being the name of the inlet from the Little Laramie to Lake Hattie, 14,053 acre feet; to the ditches between No. 2 dam and Two Rivers, 17,245 acre feet, and below Two Rivers to the intermediate ditches and Wheatland Reservoir, 37,556 acre feet.

We find, Exhibit K, that storage in Lake James from the Little Laramie commenced about April 21, 1912, and ceased about August 3, 1912, and that storage from the Little Laramie River in Lake Hattie Reservoir commenced about June 4, 1912, and ceased August 10, 1912.

Based upon his eleven months record for 1913, and adding the amount charged to the Bellamy Canal, he estimates the total discharge for the year as 58,361 acre feet, distributing to the Bellamy Canal and Lake James 12,310 acre feet; nothing to Lake Hattie from the Little Laramie in 1913, but to the ditches between this point of measurement and Two Rivers, 22,254 acre feet and to Wheatland Reservoir and the intermediate ditches below Two Rivers, 23,397 acre feet. It must be borne in mind that the mean referred to in this table does not include the amount of water diverted by the Bellamy Canal; contended for by Mr. Meeker.
that would have to be added to get the total amount even as

Exhibit J was superseded by Exhibit T-8, introduced when Mr. Meeker was called by the complainant in rebuttal. It purports to give full measurements for the year 1913, and for the months of January, February, March, April and May, 1914. Having his full record for the year, 1913, he increases his total flow for that year from 58,361, estimated from eleven months record (Exhibit J), to 59,637 acre feet.

It is to be noted that these tables charge nothing against the diversions made above the points of measurement, in other words, in Exhibit B, I and T-7, the measurements refer to the

flow of the Laramie River at the Pioneer Dam and do not include water diverted above that point. This exclusion covers whatever irrigation there may be in Wyoming above that point and also the irrigation on the Laramie Valley in Colorado, together with the diversions through the Sky Line and the Divide Canal or Wilson Supply, these last two diversions being 20,000 acre feet per annum as an average. The exhibits referring to the Little Laramie, that is J and T-8, show the measurement of water flowing in the Little Laramie after diversions for the irrigation of the Centennial Valley, and diversions by the Loback canal have been made. Attention is directed at this time to the fact that while Mr. Meeker made no charge against the Little Laramie River for this irrigation, he nevertheless did include this Centennial Valley land so irrigated in his estimate of the total amount of land irrigated in the Little Laramie Valley (Exhibit E), which will be referred to later. We contend that inasmuch as he neglected to charge anything for the irrigation of these lands, this plan being consistent with that adopted by Colorado with respect to the lands irrigated in the valley of the Big Laramie in Colorado, that he ought not to attempt to include this land in his list of irrigated acreage depending for irrigation upon the Little Laramie River. We merely make this statement at this time to show the inconsistency of his position in this regard.

Mr. Meeker adhered with remarkable tenacity to these tables, Exhibits B, I and T-7, as the basic data for his conclusion above referred to that the average flow of the Laramie River at Woods Landing was 200,000 acre feet per year.

Mr. Field, in his testimony, in order to arrive as nearly as possible at a normal yearly precipitation, went to the Poudre River where he had a series of records covering a period of over 30 years, on the theory that an average could be more accurately arrived at from 30 years' records than from the records of a materially less number of years upon the Laramie. He found, as will hereafter be specified, that the year, 1912, was very slightly in excess of normal. Mr. Meeker, following the same idea, went to a more remote stream, that is, more remote in so far as the point and conditions of observations were concerned, that is, to the North Platte River, and taking the records of the United States Geological Survey at Saratoga, which was admittedly below all irrigation in North Park in Colorado, a very considerable amount, for eight years between 1903 and 1913, inclusive, determines that for the North Platte River at that station, the year 1912 was 115.5 per cent of normal, Exhibit T-9, and he argues from that that the year 1912 was approximately 115.5 per cent of normal for the Big Laramie River.

The complainant introduced no measurements or records of the stream flow other than those of Mr. Meeker, although in

rebuttal, when Mr. Meeker concluded that the normal yearly run-off at Woods Landing was 200,000 acre feet, he contended that he had reviewed other records, but these were neither produced nor were we told of what they consisted.

Contending that the year 1912 was 115.5 per cent of normal, he finds 207,000 acre feet, in round numbers, passing the Pioneer Dam on the Laramie River, based upon gaugings made at that station. However, there had been diverted above, the water taken by the Sky Line and Divide Ditches in Colorado, which, as explained, will amount to 20,000 acre feet per annum as an average. As a matter of fact, they happened to be slightly above the average in the year 1912. As shown by Exhibit 124, they were 20,986 for the Sky Line and 2,157 for the Divide, or a total of 23,143 acre feet. This amount, if added to Meeker's 207,000 acre feet at the Pioneer Dam, would make a total of 230,143 acre feet. This is stated to show that Meeker's estimate of an average flow of 200,000 acre feet per annum is the net flow rather than the gross at Woods Landing.

As will be shown later, the diversions which can be made through the Greeley-Poudre tunnel, according to Mr. Field's estimate of the water supply, which is larger than Mr. Meeker's estimate, will be 56,000 acre feet per annum. This is based upon the Greeley-Poudre system as planned and partially constructed. Therefore, according to Meeker's estimated net flow, the Colorado diversion sought to be enjoined would be 56/200ths of the net amount of water in the Laramie River after the Sky Line and Divide Diversions have been supplied. There is a possibility of an enlargement of the Greeley-Poudre system by the extension of one of the collection ditches to McIntyre Creek. This, it is estimated, would give an additional 15,000 acre feet through the tunnel. While this is not planned as part of the Greeley-Poudre system, it is possible, and if ever constructed, it will enable Colorado to take 71/200ths of the net flow as Mr. Meeker finds the net flow at Woods Landing after the Sky Line and Divide Ditches are supplied.

It will be shown elsewhere that the evidence discloses that this is the ultimate possible diversion under any known engineering, permissible from the standpoint of the cost in relation to the returns therefrom that can be made from the Laramie River for use in Colorado.

The complainant offered no evidence of the total water supply of the whole Laramie River drainage area, but did criticise, in some particulars, testimony adduced by the defendants in this regard.

An analysis of Mr. Field's testimony on this point shows, first, a record of flow at a station termed Glendevey, which is about nine miles immediately below the tunnel of the Greeley-Poudre system and about fifteen miles in an air line above the

Colorado-Wyoming line. This station is below the diversions made by the Sky Line Ditch and the Divide Canal and is also below all contemplated diversion by the Greeley-Poudre system, but not below a possible extension of the system, that is, it is below all the diversions which are now planned, estimated by Mr. Field at 56,000 acre feet a year, but it is not below the extra possible and ultimate diversion of 15,000 acre feet. This record is shown by Exhibit 125, and covers partial records for the respective months in the years 1904 and 1905 and the years 1910 to 1913, inclusive. There are no records for the month of December in any one of these years, but by making an estimate for the mean December flow, the mean yearly flow at this station amounts to 65,717 acre feet. This does not include the water diverted by the Sky Line Canal and the Divide Ditch, in other words, it is the net amount of the flow of the river after these diversions are deducted and eliminating the small diversions for irrigation above that point in the valley of the Laramie River itself (3419). The table gives the total drainage area of the stream above this point as 102 square miles, and this net mean annual flow would indicate a run-off of 12 inches in depth over this watershed. If to the mean yearly flow above given the diversions by the Sky Line Canal alone were added, the total would be 83,790 acre feet, indicating a depth of run-off for the watershed of 15.4 inches, and if to this were added the diversion through Sand Creek (the Divide or Wilson Supply ditch), the total would be approximately 86,150 acre feet or run-off to the depth of 15.8 inches.

The drainage area mentioned, being the head waters of the Laramie River in Colorado, is immediately adjacent to the upper drainage area of the Poudre; in fact, the small tributaries are interlaced. Using the Poudre records before mentioned, covering a period of thirty years, for the purpose of determining the normal yearly run-off, Mr. Field concludes (3422) that the years covered by this table (Exhibit 125) in combination, give an average of 87 per cent of normal. If normal were based upon the records at Woods Landing on the Laramie River, to which reference will hereafter be made, but which cover a less number of years than the Poudre records, it would be 84.5 per cent of normal. Assuming the larger percentage, however, Mr. Field's statement is that the normal run-off at Glendevey would be 77,000 acre feet instead of 65,717 acre feet, this, again, being the net after the deduction of the Sky Line and Divide Canal waters (3422).

The witness arrives at this estimated normal by another method. 1912 is approximately normal according to the Poudre flow. The table, Exhibit 125, covers measurements made throughout the year 1912 with the exception of December. Estimating the run-off for the month of December to be 1,050 acre

feet, the run-off for that year would be 76,000 acre feet, or only 1,000 acre feet less for the year than the amount arrived at by the other method.

While it is our desire at this time to discuss the evidence relative to the flow of the Laramie River to the exclusion of other questions, it is, nevertheless, of particular interest while we have under consideration the Glendevey station, to consider the amount of water flowing in the river at that point which can be diverted by means of the inter-watershed diversions above. The records indicate that the Sky Line Canal is able to divert about 71½ per cent of the total supply furnished by the watershed above that ditch (3423), and that the Greeley-Poudre system will probably not be more efficient, although it will be able to divert the winter flow in the stream itself at the tunnel, differing in this respect from the Sky Line Ditch, which cannot, because of ice, operate during the winter months. This winter flow at the mouth of the tunnel is estimated at ten cubic feet per second. The collection ditches of the Greeley-Poudre system, based upon the experience of the Sky Line Canal, will not be able to operate during the winter, but, because of the ability to divert the ten cubic feet per second through the tunnel during the winter months, the Greeley-Poudre system will probably be able to divert 74 per cent of the net amount of water passing Glendevey, or approximately 56,000 acre feet per annum (3424). Adding now the amount which might be acquired by the possible extension of the system to the lower McIntyre, a tributary which reaches the stream below Glendevey, an additional 15,000 acre feet might be acquired (3425). This would give the total ultimate development of the Greeley-Poudre 71,000 acre feet instead of 56,000 acre feet, and by adding the 20,000 acre feet already diverted annually by the Sky Line and Divide Canals, we get the ultimate possible figure of 91,000 acre feet per annum, but a probable diversion of 76,000 acre feet per annum, which is the amount of water out of the total amount furnished by Colorado which the State of Colorado or its people can use from that stream.

Professor Carpenter estimated the total flow of the Laramie River at the state line to be in excess of 320,000 acre feet per annum. His estimate of the amount which can be diverted through the Greeley-Poudre system as planned is 70,100 acre feet, but the percentage of the total, as we will hereafter show, is identically the same as established by Mr. Field.

It is also of interest in discussing the stream measurements at Glendevey to call attention to the small amount of the drainage area which can be intercepted by the Sky Line Ditch and also by the Greeley-Poudre system. On the map attached to the answer of the corporate defendants, Exhibit 1, the drainage area which can be intercepted by the Sky Line is colored yellow

and is noted upon the exhibit as being 15½ square miles. The drainage area which can be intercepted by the Greeley-Poudre system is colored purple and is noted as 68 square miles. This was later modified slightly and was given as 63.5 square miles for the Greeley-Poudre system (1398), out of a total of 393 square miles constituting the drainage area of the Laramie River and its tributaries, including Sand Creek, within the State of Colorado.

The next station on the river at which measurements were maintained was at Decker's in Colorado, about half a mile south of the state line, and then at Boswell's in Wyoming, immediately to the north of the state line. These two stations were supposed to be the same, but a tributary stream called Stuck Creek, of considerable size, enters between the two. The court will, of course, notice that between the Glendevey station and the Decker station there are a number of tributaries into the river, among them McIntyre Creek, La Garde, Laramie Creek and Grace Creek from the west and Jimmy Creek and others not named upon the map from the east. Of all of these, the McIntyre is the largest.

Exhibit 126 gives a series of records at these two stations for part of the months of 1904, 1905, 1906 and 1908 at Decker station, and 1911, 1912 and 1913 at Boswell's station. Inasmuch as these records shown by the Exhibit 126 are published records, some being from the United States Geological Survey and some from the reports of the State Engineer of Colorado, it was thought well to refer to them in the evidence, but, as an indication of the total flow of the stream, they were deficient. This will be explained later, but the records are of interest as showing the amount of water in the stream, subject to this error, which, when known, merely confirms Mr. Field's conclusions.

The two records on Exhibit 126, that is, those for the years 1904, 5, 6 and 8 at Decker's, and 1911, 12 and 13 at Boswell's ranch (state line), are considered as one record by Mr. Field in his treatment of this exhibit, making an allowance for the inflow from Stuck Creek between the two stations, which, upon measurements made in 1912 by Prof. L. G. Carpenter and by hydrographers from the State Engineer's office of the State of Colorado in 1913, he estimates to be 9,000 acre feet per annum. It will be noticed that no measurement is complete for any one of the years mentioned.

In determining the percentage of normal for the years covered by the Decker Station, we have to go to the Poudre, inasmuch as there were no records at Woods Landing for those years. (3431) However, the percentages for the three records covered by the Boswell record, that is, 1911, 12 and 13, can be based upon either the Poudre or the Woods Landing (Laramie) records, and if a normal were estimated upon either

the Poudre or Woods Landing basis, based upon this discharge table for the limited number of months for each of the years given, the normal flow for the periods indicated would be 155,000 acre feet, exclusive of the diversions from the Laramie River into the Poudre River through the two canals mentioned, an average of 20,000 acre feet. It must be borne in mind, however, that this is not and does not purport to be a full year's record nor an estimate for a full year. On the same basis, in order to determine the amount of Colorado water at this point, there must be added the portion of the water of two tributary streams, Johnson and Beaver Creeks, which have part of their drainage areas in Colorado and part in Wyoming. From measurements made, Mr. Field estimates that the Colorado drainage alone contributes 16,000 acre feet through Johnson Creek and 6,000 acre feet through Beaver Creek, or a total of 22,000 acre feet, making a grand total of 197,000 acre feet. This does not include any water flowing into Wyoming through Sand Creek. The Decker Ranch records were very questionable; in fact, there are two sets of records, one according to the gauge heights reported by the water commissioner and the other as published by the United States Geological Survey, those shown by the water commissioner being very much higher. The station was established in 1904 by Mr. Lamb, a hydrographer for the United States Geological Survey, who furnished the water commissioner, Mr. Decker, with a rating table and Decker kept records based upon this rating table. The published record was made by the United States Geological Survey, reported in Water Supply Papers 171 and 172, and a great variance appears between the Decker reports based upon the Lamb rating table and the published reports. For illustration, in the month of July, 1904, according to the Lamb rating table, the discharge was 14,193 acre feet, whereas, according to the published figures which are adopted in Exhibit 126, the discharge was only 12,746 acre feet; August, according to the Lamb rating table, was 5,922 acre feet as against 4,667, the published record; in September, 3,453, according to the Lamb rating table as against 2,547 in the published records; again, in October, 3,493 as against 2,577; the aggregate for the months of July to October being, according to the Lamb rating table, 27,061 as against 22,537 shown by the published record. Attention is drawn to the fact that Exhibit 126 shows the published or lower record.

Another error appears in this, that in the year 1904, comparing the published record at Decker Station for July with the Glendevey Station for the same month, the inflow between the two stations was only 2,606 acre feet, whereas McIntyre Creek and other creeks mentioned augment the river between

these two points and an increase of 2,606 acre feet between the two stations is manifestly low.

Because of these obvious errors, these Decker records shown on Exhibit 126 were discarded (3431-3437).

The discrepancy between the Lamb rating table and the published records is not definitely accounted for. However, inasmuch as the records were prepared probably in Washington and published some years after they were taken, there is ground for believing that the error occurred there, particularly in view of the fact that on one of the records a statement is noted to the effect that certain gaugings were probably too high because of a defective meter. A defective meter, however, would show a discharge lower than the actual discharge, rather than one higher than the actual discharge (3436), so that the explanation is not satisfactory, but regardless of what explanation may be made, the fact remains that the published records are considerably lower than those based upon the rating table made by the hydrographer Lamb.

The Boswell records, however, are retained, but they are subject to a criticism, which will be mentioned later, that is, that the station did not measure all of the water passing at high water by reason of a peculiar topographical condition at the station.

These two tables should also be criticised in justification of discarding the Decker records from another viewpoint. The mean for the Decker Station for the months given in the respective years seems to be 116,797 and that at Boswell's 132,247 acre feet. Based upon the Poudre River standard of normal, the years covered by the Decker records would give 101 per cent of normal, while those given by the Boswell records, based upon the Poudre standard, would be 81 per cent of normal, or based upon the Woods Landing standard, 85 per cent of normal. It is therefore obvious that the Decker records are manifestly low.

The next station below Boswell's on the river is Woods Landing, some nine miles below the state line. In the analysis of the water supply question, Mr. Field proceeds to the records taken at this station and refers to Exhibit 127, which shows the discharge of the Laramie River in acre feet for the months of April to October, inclusive, during the years 1895 to 1900 and 1911 to 1913. The table, in the second column, shows, also, the amount diverted through the Sky Line Canal and Sand Creek or Divide Ditch, giving a total, with this added amount, of 216,244 acre feet. (3439.) This figure does not include the flow for the winter months, that is, November to March, inclusive, during any one of these years. Then, from the percentage of flow for each fractional year, based upon this mean as shown, and also the percentage of normal based upon

the normal flow of the Poudre, it appears on the table that the years covered by this table, in combination, are 96.1 per cent of normal, and that normal would be 225,000 acre feet, the mean for the months of April to October.

Exhibit 128 is a table showing the discharges of the Laramie River at Woods Landing for the various months upon which measurements were taken for the years 1889 to 1900, inclusive, and 1911 to 1913, inclusive. This table is based upon various records. The figures for the 1912 record are taken from Mr. Meeker and are shown on his table, Exhibits B, I and T-7. Some figures are preceded by the letter A. They were furnished in the year 1911 by a deputy State Engineer of Wyoming, Mr. Harry True, from unpublished records in the office of the State Engineer of Wyoming, at the request of the officers of the Greeley-Poudre District, in order that they might ascertain as nearly as possible the total run-off of the Laramie River. If all the records in this table are used, the flow at Wood's Landing, exclusive of the diversions of the Sky Line and Divide Ditches, is indicated at an average of 254,111 acre feet (3441) and this figure does not include the run-off in Sand Creek from Colorado. In analyzing this table, the witness discards the records prior to and including the year 1894 as being subject to question, and uses only the subsequent years, and of these subsequent years only the records between April and October as a basis for his conclusions, because the winter records were not numerous, and, in one case, subject to criticism (3441) as being much above the average for their corresponding months. This disposes of the contention of the complainant that Mr. Field took only the higher records, discarding the lower, in reaching his conclusions.

Referring again to Exhibit 127, the average discharge, excluding the amount taken through the Sky Line and Divide Canals, is 198,545 acre feet for the months of April to October, inclusive. The flow of these months being about 90 per cent of the annual flow (3442), makes the average discharge for the whole year 220,490 acre feet. (3442.) All of these years in combination, as indicated in the table, are 96 per cent of normal, based upon the Poudre standard. The normal average discharge, therefore, for the year, would be 230,000 acre feet, which, coupled with the 20,000 acre feet passing through the Sky Line and Divide Ditches, would make a total of 250,000 acre feet passing Wood's Landing, and this is exclusive of the supply furnished by Sand Creek. The total inflow between Boswell's and Wood's Landing is estimated at 35,000 acre feet of which 22,000 acre feet, as heretofore stated, is furnished by Colorado, making an inflow from Wyoming between the stations of 13,000 acre feet. If this be deducted from the 250,-

000 acre feet, it leaves 237,000 acre feet as furnished by the State of Colorado, exclusive of Sand Creek.

By another method, we get a similar result—that is, taking 216,244 acre feet as the total run-off, April to October, at Wood's Landing, according to Exhibit 127, including the Sky Line and Divide Ditches, the years in combination being 96 per cent of normal, gives a normal for these months of 225,000 acre feet. Now, estimating this as being 90 per cent of the yearly total, in other words, estimating the winter flow, November to March, inclusive, as being 10 per cent of the total amount, which is less than one-half of the amount actually shown on Exhibit 128 as the winter flow, gives a total to Wood's Landing of 250,000 acre feet. Again deducting the 13,000 acre feet supplied by Wyoming through intermediate tributaries, gives 237,000 acre feet at the state line exclusive of the amount of water contributed from Colorado to Wyoming by Sand Creek. (3443.)

By still another method the same conclusion can be reached. The Boswell Station record (Ex. 126) gives a mean for the period covered, April to November, inclusive, based upon a three years' record, of 132,247 acre feet, to which should be added 20,000 acre feet for the Sky Line and Divide ditches. These months represent about 92 per cent of the annual flow which would therefore be, including the Sky Line and Divide ditches, 165,700 acre feet. The three years covered, 1911, 1912 and 1913, represent 72, 104 and 51 per cent, respectively, of the normal flow as established by the Wood's Landing records; or, in combination, 75 per cent. On this basis the total discharge would be 220,933 acre feet, to which must be added the Colorado water in Johnson and Beaver creeks of 22,000 acre feet, making a total across the state line of 242,933 acre feet, exclusive of the Sand Creek discharge (3444).

Still another method may be employed in confirmation of these different conclusions. Considering the year 1912 approximately normal, the discharge, as shown on Exhibit 127, at Wood's Landing, for a period April to October, inclusive, 1912, is 236,550 acre feet. This period, as before stated, covered about 90 per cent of the annual discharge which would therefore be 262,830 acre feet, and if, instead of the estimate of 90 per cent for the period April to October, 1912, covered, we use the winter flow as given by the record (Ex. 128), the total discharge at Wood's Landing for 1912 would be 256,396 acre feet, and if again a deduction is made, for the reason that 1912 appears (Ex. 127) to be 104 per cent of normal based upon the Wood's Landing records alone, then 100 per cent of the normal would be 246,500 acre feet, from which again must be deducted the 13,000 acre feet of Wyoming water discharged through Beaver and Johnson creeks, leaving 233,500 acre feet as the annual

discharge at Boswell's (state line), exclusive of the Sand Creek discharge (3444).

Another method is to take the Boswell's Station records for the year 1912, April to October, inclusive, of 182,248 acre feet, adding thereto the amount actually diverted by the Sky Line and Divide ditches in that year, 23,143 acre feet (Ex. 124), making a total of 205,391 acre feet. These months represent 90 per cent of the total annual discharge which would therefore be 228,821 acre feet, to which must be added the Colorado water discharged by Johnson and Beaver creeks, or 22,000 acre feet, giving a total discharge across the state line of the Colorado watershed, exclusive of Sand Creek, of 250,821 acre feet. Again considering 1912 as 104 per cent normal, based upon the Wood's Landing records, the normal yearly flow would be 242,000 acre feet (3445).

By still other methods of calculation, the average yearly flow of the Laramie River at Boswell's, together with the Colorado water furnished below by Johnson and Beaver creeks, but exclusive of Sand Creek, is 237,000 acre feet, 233,500 acre feet, and 242,000 acre feet, the average of which is 237,500 acre feet, slightly less than the average if the methods heretofore mentioned are taken as the basis (3445).

As previously stated, the 1912 record, Exhibit 128, is taken from Mr. Meeker's table of the discharge of the river at Pioneer Dam, as is shown on complainant's Exhibits B, I, and T-7. That this record is incorrect and shows entirely too low a flow, appears from this: the record for the year is limited to the months of April to December, inclusive, and for the months of June and July he actually shows a less discharge than appears at the Boswell station for those months, notwithstanding there is a considerable run-off during these two months from the territory lying between the two stations. Exhibit 129 apparently is prepared to show the difference in the discharge. As a matter of fact, however, the table is based primarily upon the records at Boswell's, to which are added the records of the inflow, the sum being the flow at Wood's Landing. A casual inspection of the exhibit, without reference to the testimony, would indicate that certain Wood's Landing records were taken, from which the Boswell records were subtracted, to show the inflow. The evidence, however, discloses that the opposite method was employed in arriving at the amount of the flow at Wood's Landing; that is, the Wood's Landing record, as shown on Exhibit 129, was arrived at by adding to the Boswell station the inflow between Wood's Landing and Boswell's. The evidence shows that in 1911 the difference of discharge between the two stations was 5,600 acre feet for May; 10,975 for June; 1,916 for July; 2,700 for August; 664 for September; and 465 for October; or a total for the period, May to October, inclusive,

of 22,311. In other words, that was the inflow between Boswell's and Wood's Landing, and 1911 was a year of less than normal flow, probably about 72 per cent of normal (3449).

The records for 1913 show a difference between the measurements at the two stations of 4,123 acre feet for May, 1,217 for June, 936 for July, 1,210 for August, 1,616 for September, 1,044 for October, 45 for November; and, estimating the inflow for April at 1,500, makes a total for the period covered in 1913 of 11,681 acre feet. The year 1913 was about 51 per cent of normal, so that it appears from an analysis of these tables that Mr. Meeker's 1912 record for the Pioneer Dam (Exhibits B, 1, and T-7) are probably more than 10,000 acre feet too low for the month of June, and more than 20,000 acre feet too low for the full year (3449).

In 1912 the records on Exhibit 129 were largely estimated. The inflow between the stations, based upon the discharge of Johnson and Beaver Creeks and other accretions, seems to be about 40,000 acre feet, but a conservative estimate was made of 32,059 acre feet (3451). As confirming the estimates made for the respective months of the year 1912, certain measurements made by the hydrographer for the office of the State Engineer of Colorado, can be used. These measurements were made in the year 1913 and were: 6 in May, 7 in June, 5 in July, 1 in August, 1 in September, and 1 in October. Using these as a basis, the difference between the two stations would be as follows: May, 5,547 acre feet; June, 2,211; July, 381; August, 380; September, 586; and, estimating 1,500 acre feet for April and 500 acre feet in October to complete the period covered by the 1913 table, Exhibit 129, we have a total of 11,105 acre feet, thereby confirming the other measurements shown on the table for the year 1913, which total 11,636 acre feet (3451).

Now, assuming the year 1912 to be approximately normal and the year 1913 to be slightly in excess of 50 per cent of normal, and taking the measurements for the fractional part of the year, we can arrive at the conclusion that the normal difference between the two stations for the year 1912 would be between 30,000 and 40,000 acre feet, that is to say, the Wood's Landing record for the year 1912, if correct, should show between 30,000 and 40,000 acre feet more than is shown at Boswell's, thereby confirming the statement that Mr. Meeker is low in his 1912 measurements at the Pioneer dam (3453).

The drainage area of Sand Creek in Colorado is given, for this purpose, as about 50,000 acres (3445), although other witnesses place it as high as 81,000 acres. The run-off from the area should be one-third of an acre foot per acre, and if the lowest estimate of the area be accepted, that is, 50,000 acres, the run-off in Colorado through Sand Creek is 17,000 acre feet per annum, which, if added to the 237,000 acre feet, the average

for the Laramie River itself, the total amount furnished by Colorado is 254,500 acre feet. (3444.)

Let us depart for a moment from the question of water supply and consider the relative amount of this Colorado water which can be diverted. As previously stated, the average of the diversions made by the Skyline and Divide ditches is 20,000 acre feet, or 8 per cent of the Colorado water. The Greeley-Poudre District, through the tunnel, according to Field's estimate, can take 56,000 acre feet, or 22 per cent additional, and if the Lower McIntyre development should ever be added, making a total through the tunnel of 71,000 acre feet, the Greeley-Poudre diversion would be 28 per cent of the total, or a combined total through the Skyline and Divide canals, the Greeley-Poudre system as planned and all possible diversions from the river by means of the Lower McIntyre extension, of 36 per cent of the supply which the State of Colorado itself furnishes to the Big Laramie River. (3445.)

If we should eliminate entirely the supply furnished by Sand Creek of 17,000 acre feet, and, on a basis of a total diversion of 91,000 acre feet by Colorado, there would still be included in these Colorado diversions only 38.4 per cent of the Colorado water. (3446.)

In other words, eliminating Sand Creek, 38.4 per cent would then represent the extreme limit of the Colorado diversions under any and all circumstances from the Laramie River. Without the extension of the Greeley-Poudre system to the Lower McIntyre, the total diversion would be 30 per cent, or, reversing the statement, the fact is, that including the Skyline diversion, the Divide or Sand Creek diversion, and the Greeley-Poudre tunnel diversion, 70 per cent of the water of the Laramie River watershed arising within the State of Colorado must pass into the State of Wyoming, notwithstanding anything which Colorado might do in the future, with the exception of the one extension to the Lower McIntyre. (3446.)

It therefore appears that by its bill of complaint in this cause, Wyoming is seeking not only the 70 per cent of Colorado water which it must and will receive, but in addition to that, the 22 per cent which it is proposed to divert to the Greeley-Poudre tunnel.

The Little Laramie.

In taking the measurements of the flow of the Little Laramie River, no attempt has been made to charge anything to the use of the water in the Centennial Valley, which, as before stated, is similar in many respects to the Colorado area of the Laramie Valley. All water consumed by the ditches in the Centennial Valley is therefore eliminated from consideration in the tables given of the Little Laramie flow. (3469.)

Exhibit 131, produced by Mr. Field, is a table giving the discharge measurements of the Little Laramie River at Hatton, Wyoming, near the point where the river emerges from the mountains onto the Laramie Plains. The measurements were made at a place called May's Ranch for the years 1902, 1903, 1911 and 1912, and the records are from U. S. Geographical Survey publications, while the 1913 record is the flow at the Lake Hattie Inlet plus the flow in the Bellamy Canal, the figures being furnished by Mr. Meeker. (3705.) The Bellamy Canal is one of the ditches diverting water from the Little Laramie to Lake James. In addition to this one there is also another large ditch which diverts water from the north fork of the Little Laramie. It is above the station and therefore its diversions are not included in the flow of the stream. This ditch is commonly called the Loback Ditch. This table indicates an average discharge for the years given of 93,373 acre feet, but there are partial returns only for four out of the five years given. The only complete record, 1913, was one of very low flow. The average discharge of the Little Laramie, as shown by this table, for the months of April to October inclusive is 86,828 acre feet. There is no record at Wood's Landing on the Big Laramie for the years 1902 and 1903, so, going to the Poudre for the percentage of normal, we find that 1902 was 51 per cent and 1903 116 per cent of normal. 1911, based upon the Wood's Landing record, was 72 per cent; 1912, 104 per cent, and 1913, 51 per cent. These, in combination, being 80 per cent of normal, the normal discharge for the period, April to October inclusive, would therefore appear to be 108,535 acre feet, and for the entire year, 120,600 acre feet. (3470.)

Comparing the discharge of this station with that of the Big Laramie at Boswell's or Wood's Landing, we have still a further check upon what is probably the normal discharge of the Little Laramie at this station. The normal discharge of the Big Laramie at Boswell's has been given as 220,933 acre feet. With the Little Laramie calculated at 120,600 acre feet, the percentage would be 55 per cent of the Big Laramie at Boswell's, or 61 per cent if we exclude the Sky Line and Divide ditches. (3470.)

The winter discharge at Boswell's appears to be 4,185 acre feet per month. 55 per cent of this amount would probably represent the winter flow of the Little Laramie at Hatton. This would be 2,400 acre feet per month, or 12,000 acre feet for all winter months, which, added to 108,535 acre feet, the normal for the period April to October inclusive, would give a total discharge for the year of 120,535 acre feet, arriving at the same conclusion by a different method. (3471.)

By still a further analysis of figures at Boswell's and Hatton, based upon the record for months that are common to both

stations, Mr. Field arrived at the conclusion that the flow at Hatton on the Little Laramie was 55 per cent of the flow of the Big Laramie at Boswell's, and by another analysis arrives at the conclusion that the discharge of the Little Laramie at Hatton, based upon the records in these calculations, was 120,700 acre feet per annum as an average for normal. (3472.)

It next becomes of interest to consider the total amount of water available annually for the Laramie Valley as a whole. We have heretofore shown by the witness Field that the annual normal discharge at Wood's Landing on the Big Laramie River is approximately 250,500 acre feet, and on the Little Laramie at Hatton, 120,700 acre feet. Turning again to the consideration of the Big Laramie, there is a tributary that enters the stream below Wood's Landing called Fox Creek, with an estimated annual run-off of 14,400 acre feet. (3473.)

The total available water above the Wheatland Reservoir must also include the run-off from the mountain territory through Four Mile, Seven Mile, Cooper and other small streams heading in the mountains north of the Little Laramie, and on the west side of the Laramie Plains. This mountain territory is about 60 square miles in extent or 38,400 acres. A conservative estimate would place the run-off at one-third of an acre foot per acre per annum, yielding from this territory 12,800 acre feet. (3474.)

The mountain area on the east side of the Plains should also be considered. This area from a point opposite Two Rivers down to the Wheatland Reservoir is about 60 miles in length and about 5 miles in width on an average. Assuming it to be 3 miles in width, it should furnish an annual supply of 12,800 acre feet based upon one-ninth of an acre foot run-off over the area. (3474.) There is also doubtless considerable water furnished from the Laramie Plains area proper, which is very extensive, being in the neighborhood of 600,000 acres, but inasmuch as this inflow will be erratic, due almost entirely to violent storms, no charge was made by Mr. Field on that account. The total average supply from the Laramie River and its tributaries above the Wheatland Reservoir is 411,200 acre feet, the sum of the amounts just given. (3474.)

Below the Wheatland Reservoir some water enters the river in the canon from tributary streams from the mountain area lying principally to the north of the river (Duck Creek, Dodge Creek and others). This, however, has not been charged against the total supply available for the use of the Wheatland system. There is the flow of Blue Grass and Sybille Creeks. Measurements have been made of the flow of these streams from which the witness concludes that these two streams furnished 20,000 acre feet or more annually, making a total

supply above the Wheatland tract of 431,200 acre feet, the normal average flow. (3476.)

However, this must not be considered all of the water of the Laramie River, inasmuch as it does not take into consideration the water available from the North Laramie River which enters the main stream from the north, heading in the vicinity of Laramie Peak, nor the Chugwater, which enters the main stream from the south, heading on the eastern slope of the Green Mountains. As heretofore stated, these streams converge near the station called Uva and generally below the Wheatland area. There is some irrigation on both these streams and from reports published by the State Engineer of Wyoming for the years 1911 and 1912, the discharge of Chugwater near its mouth was 18,300 acre feet per annum. (3476.) The total discharge, therefore, of the stream in the Colorado and Wyoming areas would seem to be in excess of 450,000 acre feet without considering the flow of the North Laramie. Of this amount Colorado furnishes something in excess of 250,000 acre feet and in turn can use only the amount of the present diversions through the Sky Line and Divide canals, 20,000 acre feet; through the tunnels and collection ditches as planned, 56,000 acre feet, and through the other possible diversion from the river by the extension of the system to the lower McIntyre, 15,000 acre feet, making a total possible diversion of 91,000 acre feet.

Confirming Mr. Field's estimates, two other tables were also introduced. Exhibit 143 is a table showing the discharge of the Big Laramie River immediately above its junction with the Little Laramie River, the point being called Two Rivers. Record covers portions of the years 1909, 1910, 1911, 1912 and all the year 1913, the mean discharge at that point being 126,753 acre feet.

Exhibit 144 is a similar table showing the discharge of the Little Laramie River immediately above its junction with the Big Laramie River, this point also being termed Two Rivers.

The court will understand that measurements were made immediately above the junction upon both branches of the stream after all upper diversions including the Pioneer Canal, Lake Hattie and Lake James had been made. In each case the station was termed Two Rivers.

The Little Laramie station records, Exhibit 144, cover the same years as Exhibit 143. There was a mean discharge of 50,132 acre feet per annum, the mean being based upon the measurements for the respective months shown on the table.

The combined means at Two Rivers station, that is, 126,753 acre feet on the Big Laramie, and 50,132 acre feet on the Little Laramie, 176,885 acre feet, represent the total flow of the Laramie River immediately at the junction, and inasmuch, as has

been heretofore shown, as there is relatively a small amount of irrigation below this point and the Wheatland Reservoir, it therefore follows that the major portion of this water is available for the Wheatland system. If Mr. Meeker be correct in his estimate of the capacity of the Wheatland Reservoir at 83,500 acre feet, there is therefore at this point available more than twice the capacity of the reservoir, and if the reservoir capacity be 126,000 acre feet, there is a surplus above that amount of 50,000 acre feet per annum.

Lake Hattie and Lake James, the other two large reservoirs, and by far the greater portion of the irrigation in the Laramie Plains, are above Two Rivers. Referring to plaintiff's Exhibit K, we learn that Lake James was storing water from April 21 to August 3 in 1912 and from April 19 to May 25 in 1913; and that Lake Hattie, which receives water from both the Big and Little Laramie Rivers, commenced storing from the Big Laramie April 8, and ceased October 5, 1912. Apparently recommenced and ceased again December 26 and commenced storing water from the Little Laramie June 4 and ceased August 10, 1912, and in 1913 commenced storing from Big Laramie April 25 and ceased on June 13, receiving no water from the Little Laramie in 1913.

An inspection of Exhibits 143 and 144 shows that after this storage had been made by these two reservoirs, although it continued in 1912 practically through the irrigation season and in 1913 well into the irrigation season, nevertheless there was abundant water in the streams at the junction for every need below; although the court will recall that while the year 1912 was approximately normal or slightly above normal, the year 1913 was only about 55 per cent of normal.

Further supplementing his conclusions, the witness reviews the evidence given by Wyoming relative to the amount of water stored in the various reservoirs in that state diverting water from the Laramie River or its tributaries.

Referring first to Lake James, according to the testimony of Z. E. Sevison, a witness on behalf of the State of Wyoming, the capacity of this reservoir is 41,100 acre feet (631). This reservoir was constructed in 1908 or 1909, although not really completed until 1911 (633). Water was first stored for irrigation in the year 1909. In that year the storage was 18,000 acre feet, a small amount of which was used and the balance carried over. Including this amount carried over, the storage in 1910 was 10,000 acre feet, and at the end of that season the lake was practically empty. In 1911, 10,000 acre feet was stored and all used; in 1912, the storage was 22,000 acre feet, of which about 18,000 acre feet was carried over the irrigation season, in other words, not used; and up to March, 1913, 3,000 acre feet additional had been stored. According to Exhibit J, a table

produced by R. I. Meeker, a witness for the State of Wyoming, there was diverted into the Bellamy Canal and Lake James from the Little Laramie River, 24,793 acre feet in 1912, and in 1913 to November 30, 12,310 acre feet. According to Exhibit K, Mr. Meeker found that on July 17, 1912, there was 15,000 acre feet in storage in Lake James, and on November 25, 1912, 18,400 acre feet, and that storage commenced that year April 21st and ended August 3rd; on April 25, 1913, 20,400 acre feet; October 30, 1913, 19,800 acre feet, and that storage commenced that year April 19th and ceased May 25th. Sevison testified that there was no water carried over from 1911 to 1912; so by deducting the amount in storage November 25, 1912, 18,400 acre feet, from the diversions made in 1912, 24,793, we have 6,393 acre feet used or possibly lost. It appears, therefore, that in the practically normal year of 1912 there was not only an excessive amount of water available, but there was actually stored above all uses, 18,400 acre feet (3483).

Referring now to Wheatland Reservoir: according to the complainant's witness, J. A. Elliott, no water was carried over in Wheatland Reservoir from 1910 to 1911, nor from 1911 to 1912 (170). According to the Wyoming hydrographer, Mr. Meeker, the flow at Look Out, which is immediately above the Wheatland Reservoir, from May 27th to December 31st, 1912, was 119,770 acre feet, and there was in the reservoir on May 27th, 1912, 36,600 acre feet (Exhibit K). There was, of course, considerable flow into the reservoir prior to May 27th, as the high water in the river begins prior to that date. Assuming this amount to be 6,000 acre feet, which is conservative, there was into or through the reservoir in 1912, 162,370 acre feet (3483). There was withdrawn from the reservoir in 1912, as shown by the records at McGill station on the river below the reservoir, 95,653 acre feet, and it is known that there was water discharged from the reservoir at a date in 1912 earlier than that shown by the McGill station records. Assuming that to be 6,000 acre feet, the total amount drawn through the reservoir was 101,653 acre feet (3483), which subtracted from the amount into or through the reservoir, 162,370, leaves a balance of 60,717 acre feet (3484), while Meeker, according to Exhibit K, states that on November 18, 1912, there was 43,000 acre feet left in the reservoir, and from November 18th to the end of the year 1912, the inflow was 5,540 acre feet; or, according to Meeker's estimate, 48,540 acre feet at the end of the year 1912. These figures are substantially confirmed by the testimony of J. A. Elliott, the engineer having Wheatland Reservoir in charge, that there was 40,000 acre feet in the reservoir at the end of the irrigation season of 1912 (170). The inflow for October, November and December was 19,070 acre feet and the outflow only 463 acre feet, leaving the amount which should be in the reservoir at

the close of the season 58,607 acre feet (3484). Allowing for evaporation, this discrepancy between Elliott and Meeker can be accounted for by the difference in their estimates of the capacity of the reservoir, Elliott basing his figures upon a capacity of 120,000 acre feet (170), while Meeker takes a capacity of 83,500 acre feet.

Referring now to Wheatland Reservoir No. 1, which is a smaller reservoir located near the center of the Wheatland tract, capable of storing water not only from the Laramie River through the Wheatland tunnel, but also water from Sybille and Blue Grass creeks; this Reservoir has an active capacity, according to the witness Elliott, of 7,000 acre feet (166), and is used for the irrigation of lands in the Wheatland tract. Complainant's Exhibit K contains the statement that there was on storage September 10, 1912, 10,500 acre feet, estimated, and on November 1, 1913, 2,100 acre feet, showing a use above any water that may have been stored in the reservoir during the year 1913 of 8,400 acre feet.

Lake Hattie, according to the Wyoming testimony, has an active capacity of 68,500 acre feet, with a dead or unavailable capacity of 42,000 acre feet additional, and the complainant's testimony showed that water was available; in other words, the dead space had been filled and water could be withdrawn in June, 1912. Complainant's Exhibit J by Meeker, shows that there was furnished from the Little Laramie alone in 1912, 14,053 acre feet, and from the Big Laramie (Exhibit I), 69,855 acre feet; or, a total of 83,908 acre feet. Exhibit K by Meeker shows that on November 20, 1912, there was 18,700 acre feet available storage in the reservoir and that no water was run from the reservoir in 1912. It would therefore seem that the difference between the total inflow, 83,908 acre feet, and the amount on hand November 20, 1912, 18,700 acre feet; or, 65,208 acre feet, is probably the dead or inactive capacity instead of the 42,000 acre feet testified to, subject, however, to this modification, that there is, of course, considerable loss by evaporation and seepage. Allowing 3,208 acre feet for this loss, the dead capacity would then appear to be 62,000 acre feet and the total amount stored in 1912, both available and unavailable, would be, with this correction, 80,700 acre feet. On April 24, 1912, according to Exhibit K, there was 19,400 acre feet stored and available and the inflow from the Big Laramie in 1913, from April 25th to some date not mentioned, in June, was, as shown by Exhibits K and I, 28,470 acre feet. On November 5, 1913, there was 26,000 acre feet in the reservoir (Exhibit K). There was, therefore, used or lost through evaporation, seepage, etc., 21,870 acre feet. Allowing for possible loss by seepage and evaporation, 5,000 acre feet; the use of the reservoir was 16,870 acre feet for the year 1913, which is admittedly a very low year

in the amount of water supply. Nevertheless, during this low year, Lake Hattie succeeded in increasing its storage above its use and loss by evaporation, from 18,700 acre feet on November 20, 1912, to 26,000 acre feet November 5, 1913; or, 7,300 acre feet, without taking any water whatever from the Little Laramie River in that year (3487).

It therefore appears that there was stored in these reservoirs, in the year 1912, above the amount actually used for irrigation from the reservoirs, the following:

In Lake James.....	18,400 acre feet
Wheatland No. 2.....	47,000 acre feet
Wheatland No. 1.....	10,500 acre feet
Lake Hattie	80,700 acre feet
Or a total of.....	156,600 acre feet

This amount, 156,600 acre feet, is manifestly the amount stored in excess of the use and evaporation from the reservoirs in that year (3488).

Furthermore, the records at Wheeler's Bridge, which is on the Laramie River below the canon, for the year 1912, indicate that there was about 10,000 acre feet of water passed that point, which is above the mouth of Sybille Creek. 1912 was a year of larger flow than 1913, and yet the records for the year 1913 show that there was 19,000 acre feet discharged by Sybille Creek. 1912 would undoubtedly be greater and probably as much as 20,000 acre feet. Chugwater, for the year 1912, according to the records, discharged 18,300 acre feet. Adding these amounts to that left in the reservoirs, 156,600 acre feet, gives a total of 204,900 acre feet, the aggregate amount carried over in storage (above the use) and the amount wasted (3489). Estimates of seepage loss, of course, may vary. If it be contended that Field's estimates in this regard are low, then his estimate of this amount of surplus water, 204,900 acre feet, would be reduced accordingly.

The witness Field increases this amount by the addition of estimates of loss by evaporation and waste not heretofore detailed, a consideration of which is not necessary for this argument. However, this amount, 204,900 acre feet, must not be understood as being the total supply of water for irrigation for that year. It does not include the amount used, either by direct irrigation from the river through the ditches, or the use from the reservoirs themselves. It is merely the amount carried over in storage that year plus the amount passing down the river at Wheeler Bridge and the amounts discharged into the Laramie River from Sybille and Chugwater Creeks.

According to the witness Elliott for Wyoming, the amount of water furnished to the Wheatland tract in the year 1912

was 100,000 acre feet (170). The amount diverted through the Pioneer Canal in that year, according to Meeker, was 17,703 acre feet (Exhibits B, I and T-7), all other ditches between Pioneer Dam and Two Rivers (Big Laramie), 29,892 (Exhibit T-7), ditches between No. 2 Dam and Two Rivers (Little Laramie), 17,245 (Exhibit T-8). These amounts added to the sum of 204,900 acre feet, give 369,740 acre feet, and still do not account for a large amount of irrigation through numerous other ditches.

Referring again to the 1912 records, showing an inflow into Lake Hattie Reservoir from the Big Laramie River of 69,855 acre feet, as shown by Mr. Meeker on Exhibits B, I and T-7, and which were adopted by Mr. Field in his analysis of the Wyoming evidence, it is of interest at this time that, in rebuttal, Mr. Meeker criticised Mr. Field's analysis, particularly his graphs showing the flow and use of water on the Big and Little Laramie Rivers for the year 1912, Exhibit 136, and 1913, Exhibit 141, contending that he had duplicated the amount of water diverted by the Pioneer Canal, the amount being 17,703 acre feet in 1912 and approximately 12,000 acre feet in 1913, and that the error had been carried through both charts. Upon being challenged on cross-examination, he corrected this statement (4322) and revised his Exhibits B, I and T-7 from which Mr. Field had taken the data relative to the distribution to the various reservoirs, and admitted that he himself had made a duplication of the 17,703 acre feet and deducted that amount from the sum which he charged to Lake Hattie Reservoir from the Big Laramie River in 1913 and added it to the amount charged to the Wheatland Reservoir No. 2 and the ditches below Two Rivers. Therefore, in so far as Mr. Field is concerned, the corrections made by Mr. Meeker in his distribution simply reduce the amount of storage for 1912 in Lake Hattie and increase the amount in Wheatland Reservoir No. 2 proportionately. The witness further corrected his testimony and admitted that the error of 12,000 acre feet which he charged in Exhibit 141 did not, in fact, exist (4323-4).

In regard to the dead space in Lake Hattie which has to be filled before any stored water is available, and which, according to the testimony of Wyoming's witness Bishop, is 42,000 acre feet, and which the witness Field states may be as great as 62,000 acre feet, it is pertinent to say that the demand for water to fill this dead space is not constant, that is, once having been filled, it will, except for the loss occasioned by seepage and evaporation, remain in the reservoir and the initial filling of the reservoir made a greater demand on the river than subsequent fillings will do. If this reservoir had been filled prior to 1912, then, with the amount of water diverted into this reservoir in that year, the reservoir would have been entirely

filled and approximately 12,800 acre feet would have been the surplus (3494).

Moreover, without any comment upon the economy of maintaining a condition which could, by the expenditure of some labor, be remedied at least in part, that is, maintaining a reservoir with this enormous amount of dead space from which there is bound to be considerable loss in any year, nevertheless the amount of water required to fill this dead space, if applied to the lands of the defendant, The Greeley-Poudre Irrigation District, would have been sufficient to have irrigated a number of acres equal to about 75 per cent of the total number of acre feet of such water for one year (3495). However, for the purpose of future consideration of the demands upon the river, this dead space can be eliminated from consideration.

To more graphically illustrate the flow of water in the river, the witness Field produced several diagrams or hydrographs showing the flow of water in the Laramie River in the year 1912.

The first of these, Exhibit 132, represents the amount of water flowing past certain points on the Laramie River from the Sky Line Canal to Woods Landing for the different months in the year 1912, differentiating between the amounts diverted to the Sky Line and Divide Ditches, the amount which could be diverted by the tunnel and collection ditches of the Greeley-Poudre System, the inflow from Glendevey to Boswell's station and from Boswell's station to Woods Landing. The hydrograph is explained by the witness in his testimony on pages 3497 to 3499.

Exhibit 133 is a similar representation based upon the flow of the Little Laramie River for the year 1912, and is discussed at pages 3499 to 3501.

Exhibit 134 is a similar diagram representing the flow and use from Two Rivers, Wyoming, the junction of the Big and Little Laramie Rivers, to Look Out, the station immediately above the Wheatland Reservoir (3501).

Exhibit 135 shows graphically the condition of Wheatland Reservoir No. 2 for the year 1912, in so far as there are available records. The diagram is constructed almost entirely upon data furnished by witnesses for the complainant. The upper curved line represents the combined flow of the Big and Little Laramie Rivers at Two Rivers station. The second line from the top represents the flow at Look Out station, the head of the Wheatland Reservoir. Both of these lines represent the total amount discharged up to any given date, but do not represent the flow at any one period. The third curved line from the top, marked "Out-flow less intake," is obtained by subtracting the out-flow as recorded at McGill station below the reservoir from the inflow. The blank area between these two lines

represents the outflow and is indicated by the scale on the graph. The bottom line designates the quantity reported in the reservoir by R. I. Meeker for the complainant, and the cross hatched area between the first and second lines represents the loss or use between Two Rivers and Look Out, or possibly errors in measurements. This exhibit is based upon the assumed capacity of 83,500 acre feet, that being the amount testified to by Meeker. If the capacity were greater than that amount, then the lines on the graph would be, as a whole, moved upward. This exhibit is discussed at pages 3502 to 3504 of the testimony.

Exhibit 136 is a mass diagram showing in a different manner the flow of the river for the year 1912 at different points and also the use of water during the year. The upper line of the diagram represents the supply of water expressed in acre feet, commencing with the source of the river and continuing to the mouth of Chugwater Creek, including also the discharge of the Little Laramie, aggregating a total of approximately 480,000 acre feet. The lower line shows the flow at the various points indicated after deducting the use or diversions from the river, and indicates that 50,000 acre feet passed down the Big Laramie River below the mouth of Chugwater Creek in the year 1912. (3505-3510).

Exhibit 137 is a mass diagram showing the amount of water from the Sky Line Canal to Wood's Landing on the Big Laramie River in 1913, similar to Exhibit 132 for the year 1912. (3538).

Exhibit 138 is a mass diagram of the Little Laramie River from Filmore to Two Rivers, showing the flow and distribution for the year 1913, similar to Exhibit 133, which was for the year 1912. (3539-3540).

Exhibit 139 is a mass diagram showing the flow and distribution of water in the Laramie River between Two Rivers and Look Out in the year 1913, similar to Exhibit 134 for the year 1912 (3541).

Exhibit 140 is a mass diagram of the inflow and outflow of Wheatland Reservoir for the year 1913, based upon two assumed capacities, the red lines indicating the inflow and outflow based upon a capacity of 123,000 acre feet, the blue lines indicating the inflow and outflow based upon a capacity of 83,000 acre feet. This diagram is similar to Exhibit 135 for the year 1912 except that Exhibit 135 was based only upon the assumed capacity of 83,500 acre feet (3542).

Exhibit 141 is a diagram for the year 1913, similar to Exhibit 136 for the year 1912, showing the accumulations of the discharge of the Laramie River and its tributaries, together with a representation of the flow after the diversions have been made and showing 30,000 acre feet passing out of the river below the mouth of Sybille Creek. This diagram does not in-

clude any discharge from Chugwater and in that respect differs from Exhibit 136. The mouth of Chugwater is below the lowest point indicated on the exhibit. (3542-3.)

Exhibit 142 shows graphically the supply and use of the water of the Laramie River in so far as it applies to the total supply of the river and the diversions by the Sky Line and Divide Ditches, and those which will be made by the Greeley-Poudre system. In other words, it graphically shows, in five columns, the total water supply by Colorado to the Laramie River and the relative amounts which will be diverted by Colorado.

Exhibits 132 to 142 are all drawn on a scale representing acre feet, the figures being noted on the scale at the left hand margin. The height to which any column or line ascends therefore indicates the number of acre feet represented. In all of them, the scale from left to right, or the horizontal scale is prepared for the various months of the year, but only in part is this scale appropriate. This will be clearly noticed when the exhibit in question is examined. In Exhibit 142 Mr. Field shows in column five the total flow of 254,000 acre feet per annum from Colorado. Column 1 shows the relative amount diverted by the Sky Line and Divide Ditches; Column No. 2, the tunnel diversion as planned, No. 3, the tunnel diversion plus the amount which might be diverted if the Lower McIntyre extension were made, and No. 4, the total of all of the Colorado diversions including the possible Lower McIntyre extension. The exhibit merely represents in graphic form the conclusions which Mr. Field arrived at as to the relative amount of Colorado water which can be diverted and which has been heretofore referred to (3544, 3545).

The witness then reviews the testimony of the Wyoming hydrographer, Mr. Meeker, considering more specifically his exhibits, which are based upon measurements through a portion of the years 1912 and 1913, as heretofore stated, although these were afterwards supplemented on rebuttal by a continuation of records to the date upon which the rebuttal testimony was given.

On complainant's Exhibit B, I and T-7, each of which is a table produced by Mr. Meeker, showing the flow of the river at the Pioneer Dam where Meeker found, or rather, estimated a flow of 207,000 acre feet for the year 1912, there is an apparent error in this, that the records at Boswell Station for 1912, exclusive of the Sky Line and Divide Diversions, shows 205,678 acre feet. There should be added the inflow from Johnson and Beaver Creeks, about 27,500 acre feet from both the Colorado and Wyoming areas, and other miscellaneous drainage sufficient to bring the total up to 239,697 acre feet at Pioneer Dam, a discrepancy of over 32,000 acre feet. The error appears to lie

particularly in the discharge for the month of June. At Boswell's Station the gaugings by the State of Colorado show a discharge for the month of 92,912 acre feet and the inflow between Boswell's and Wood's Landing from tributary streams was 9,914 acre feet, making a total of 102,826 acre feet, while Meeker in the three exhibits last mentioned, reports 91,874 acre feet, and in data furnished at the request of defendants but not introduced in evidence, showed 86,003 acre feet for the month of June. The result is that Meeker's tables are so faulty in material points as to discredit their correctness (3547).

The United States Geological Survey, according to measurements taken in the year 1912, found 94,700 acre feet in the Big Laramie alone at Two Rivers station from April 5 to October 31, inclusive, in 1912. (Ex. 143.) This would indicate an annual discharge of 120,000 acre feet against Meeker's estimate of 89,550 (Exhibit B), or a difference of 30,450 acre feet.

On Exhibit I for the year 1913, Mr. Meeker estimates 45,709 acre feet in the Big Laramie at Two Rivers, indicated on the table as "Wheatland Reservoir No. 2 and intermediate ditches below Two Rivers," while the Geological Survey records for the same year show a discharge of 54,001 acre feet (Ex. 143), a discrepancy of 8,292 acre feet (3548).

The mean shown on Meeker's tables B and I, based upon measurements for a part of the year 1912 and part of the year 1913, is misleading unless it be definitely understood that it is merely the mean of the figures given and not the mean discharge of the river. The year 1912 was approximately normal, while 1913 was only about half of normal, so that obviously the mean of these two years would not be the mean discharge of the river (3549).

Complainant's Exhibit J is also in error. It shows a discharge, June 1st to December 31st, 1912, of 93,667 acre feet at the Lake Hattie No. 2 Dam on the Little Laramie. On tables furnished defendants by Mr. Meeker, the discharge for November and December aggregated 3,760 acre feet. Deducting this amount gives a total for the period June to October of 89,907 acre feet, whereas the United States Geological Survey records for the same period show 94,200 acre feet. On the same table Meeker credits 37,556 acre feet to the Wheatland Reservoir and intermediate ditches below Two Rivers. In other words, this is the amount which he credits to the Little Laramie River at Two Rivers, exclusive of any inflow between Two Rivers and Wheatland Reservoir, he contending that there is none, whereas the United States Geological Survey for the same period shows 42,540 acre feet at Two Rivers, a discrepancy of approximately 5,000 acre feet (3551).

Complainant's Exhibit L, which is a table produced by the hydrographer Meeker, purporting to give a summary of the storage in the years 1912 and 1913 in the reservoirs, Wheatland Nos. 1 and 2, Lake James and Lake Hattie, is criticised particularly for the reason that the amount shown by this exhibit to be in Lake Hattie on November 20, 1912, 18,700 acre feet, does not show the amount of dead water which the reservoir held and which was, of course, a demand upon the river in that year and would be available, as stated, in any other year except the year of initial filling. In other respects assuming the correctness of the table, this dead water would have to be added to the total given in the summary for the year 1912 on Exhibit L (3552). If this dead water amounts to 42,000 acre feet, according to Bishop, then the total shown on the summary of 91,100 should be increased to 133,100 acre feet, or, if as estimated by Mr. Field, this dead water amounts to 62,000 acre feet, then the total amount for the year should be increased to 153,100 acre feet. It should also be noted that this table shows the storage as of date November 20th for both the years 1912 and 1913, not the total storage at the close of either year, which would doubtless be greater than the amount on November 20th.

Complainant's Exhibit M, also produced by Meeker, is criticised. This table purports to give the relation of run-off on the Laramie River between Glendevey and Wood's Landing stations and is subject to the same criticisms as have been directed to Meeker's 1912 records at the Pioneer Dam which have been previously discussed. The mean which the table assumes to produce is based upon entirely too short records, even assuming their correctness, for the year 1913 was admittedly much below normal. 1911 was also a low year, but not as low as 1913 (3553). If the comparison between the two stations was based upon the normal flow, the relation is 77,000 acre feet for the Glendevey station and 215,500 acre feet for the Wood's Landing station, after deducting the amount diverted by the Sky Line and Divide ditches at both stations. In other words, the Glendevey flow is 35 per cent of the Wood's Landing flow (3553). The note on the bottom of the exhibit which reads "Run-off at Woods, Wyoming, for July, August and September represents substantially the entire run-off of the Laramie River, except surplus from the Little Laramie River passing in occasional years and in considerable amounts produced by summer freshets" is not true. It does not include the amount diverted by the Sky Line and Divide ditches on the Big Laramie and there is heavy discharge from the Little Laramie River in all years. (See complainant's Exhibit J and T-8, prepared by Meeker and also defendant's Exhibit 131 and 144.)

Complainant's Exhibit K is criticised in this, that the statement that on May 27, 1912, there was 36,600 acre feet

in the Wheatland No. 2 reservoir is based on the assumption that the active capacity of the reservoir is 83,500 acre feet instead of 126,000 acre feet (3556) and for the further reason that there is no record as to the amount withdrawn from the reservoir prior to May 27th, but there is information that this discharge was as high as 600 cubic feet per second.

Professor L. G. Carpenter, the second witness for the defendants on the question of the amount of water available in the Laramie River, explains at length the methods adopted by hydrographers in measuring streams, with a criticism of the various methods, showing the relative accuracy of various ones (3761-3776), and then explains how rating curves and discharge curves are erected (3776-3777). He explains his study of the question of precipitation at various points affecting the run-off of the Laramie River and on streams to be compared with it in this regard, this investigation covering a period of years (3778-3784).

Professor Carpenter, while Director of the Colorado Experiment Station at Fort Collins, encouraged measurements on the Laramie River in Colorado. These were undertaken in 1902 and subsequent years by the United States Geological Survey, the hydrographer being a Mr. Lamb, a former student in the Colorado Agricultural College under Professor Carpenter (3789-3790). After the Geological Survey ceased taking measurements, Professor Carpenter furnished an automatic gauge to Mr. Decker who has been previously referred to, who took records for some time (3791) at the station known as Decker's.

In the year 1912, Professor Carpenter, with from one to three assistants, spent considerable time on the Laramie River and its tributaries, making measurements, particularly until the high water had passed. In that year there was an automatic gauge at the Boswell station which Professor Carpenter, upon examination, found to be defective in that the pen on the record had a constant tendency to show a lower discharge than actually existed in the river. Corrections were made from time to time by the witness or his assistants whenever one of them happened to be present when the record-keeper was changing the chart. Neither the witness nor his assistants had the instrument in charge and so could not correct it at all times, but only when they were able to co-operate with the keeper, who lived some distance from the station (3792-3795). On all occasions when a check was made it was found that the instrument was recording less than the actual flow of the river (3795). This chart gave the record upon which the State Engineer of Colorado based his published report.

In addition to this error, Professor Carpenter discovered what had apparently been overlooked by all hydrographers

previous to that time. By reason of a topographical formation, the river in the valley at Boswell's station flows generally northward, makes a bend, curving for a short distance to the east, and then turns again to the northward. The station where the records were obtained was located a short distance below this second bend, and it was discovered that when the water became high it overflowed and passed down through three separate channels to the west of the station, entering the river again at some point below, the result being that all of the water which passed through these extra channels escaped measurement inasmuch as only the main channel itself was in contemplation of the hydrographers making measurements, and the records, regardless of the inaccuracy of the measurements, failed to disclose the high water discharge of the river (3798). The witness immediately made measurements of the cross sectional area of these extra channels and also the height upon the gauge rod at the station in the main channel at which the overflow would occur (3798-3799). The channels in question are rather large and capable of carrying a material quantity of water. For illustration, on June 4, there was, in addition to 2,012 cubic feet per second passing in the main channel, 500 cubic feet of water per second of time passing through these three overflow channels, the total of which would have been, if correctly measured, the reported discharge of the river. On June 11 there was 220 cubic feet per second passing through the overflow channels and 1,790 cubic feet per second in the main channel (3801). This overflow continued for something more than four weeks during the period of highest flow in the river. Measurements taken by the witness and his assistants showing the discharge at various gauge heights are given (3803).

A diagram showing graphically the water which passed through these extra culverts and which was not included in the published records of the State Engineer, was introduced, Exhibit 158. In this diagram the discharge at Boswell's station, as shown by the published report of the State Engineer of Colorado is shown in yellow and the additional and greater discharge based upon Professor Carpenter's measurements, passing through the culverts and not recorded, is indicated by the red color on the diagram. The diagram covers a period commencing about the 17th of April and ending the 30th of September, and shows that about June 4, 5 and 6 the discharge was approximately 2,512 cubic feet per second. A glance at this exhibit makes clear the relative amount of water which was not included in the measurements made by the State Engineer's office and shown by his published figures. The witness Field, in arriving at his conclusions as to the flow of the stream, used the figures given by Professor Carpenter from his

actual measurements in making his determination of the flow at the Boswell station.

Professor Carpenter made no measurements personally in 1911. The presumption is that the error in the recording instrument at the Boswell station which he found in 1912 existed in 1911, and that the published record based upon the chart of the defective instrument shows a discharge less than the true discharge. The other condition, that is, that the high water in the river passed through the culverts mentioned, would be true of any year when the river reached a height sufficient to cause the overflow. An examination of the published records of the State Engineer for the year 1912 discloses that the defects in the recording instrument were taken into consideration whenever a correction was made on the chart, otherwise no correction was made, neither does the published record include the water passing through the extra culverts (3808).

The measurements made in 1912, in addition to those on the Laramie River itself at Glendevey and Boswell's, included regular observations on Grace Creek, Bear Creek, Johnson Creek, Jimmy Creek, Forrester Creek, Fox Creek, Beaver Creek, Stubb Creek, Nunn Creek, Deadman Creek, Rawah Creek, McIntyre Creek, La Garde Creek, Stuck Creek, at the Lake Hattie inlets, that is, both on the Big and Little Laramies, and on the Little Laramie and also occasional measurements on other tributary streams as opportunity permitted (3811). The data relative to these measurements was furnished to the State Engineer, John E. Field, a witness in this case (3812).

The witness reviews the hydrography of the several tributaries of the Laramie River (3813-3816), showing the relative size of each and its discharge, and also the watersheds which they drain, supplementing his investigations through the snow measurements before referred to, correlating the discharge measurements which he had taken with the depth of the snow as determined by his investigation, and describes with considerable detail the snow measurements and the relative amount of water which the watersheds would produce (3816-3823). He found that the range to the west of the Laramie River, known as the Medicine Bow Range, was a very excellent source of water supply and better than he had anticipated. We believe we are justified in stating that Professor Carpenter's wide experience in hydrographic matters, coupled with his very exhaustive investigation of the Laramie River and its watersheds, enables him to testify with far greater accuracy than if his knowledge of the situation was limited to measurements taken at a limited number of points on the stream for a portion of the year 1911, all of the year 1912 and a portion of the year 1913, as did Mr. Mecker, the Wyoming hydrographer.

Exhibit 156 is a number of photographs showing these snow measurements, the views being taken at various points from the head of the Laramie River in Colorado northward to the Centennial Mountains at the head of the Little Laramie River in Wyoming. The number on each individual picture has no connection with the case, being merely the serial number in the filing system used by Professor Carpenter, but each picture contains a legend showing the date upon which it was taken and the location. These views are described at pages 3883-3892.

The range is much broader in Wyoming than in Colorado, and, while there are some slightly higher elevations in Colorado than in Wyoming, this higher area is not extensive and the precipitation to the northward in the Wyoming area is greater than the precipitation at corresponding elevations in Colorado and a large part of the range in Colorado, that is, the part of lower elevation lying about fifteen miles south of the state line, is not so good a source of supply as is the Wyoming area (3891-3892).

During the year 1912 Professor Carpenter, in addition to his snow measurements, made many measurements on the Little Laramie River at Filmore and kept daily records. At that point the drainage area of the Little Laramie River is about 163 square miles, or 104,000 acres. The run-off for the month of June alone was 76,632 acre feet, and in July 27,676 acre feet by actual measurement, or practically a run-off for the two months of one foot in depth for the drainage area. That is, the run-off for June and July alone amounted to approximately 104,000 acre feet (3894). Contrast this with Meeker's estimate of 93,667 acre feet for the entire year of 1912 (Exhibit T-8).

Exhibit 157 is a hydrograph showing the flow of the Little Laramie River at this station, based upon measurements from May 20th to some date in October in the year 1912. It shows the flow in cubic feet per second for each day during the period covered, the highest discharge being in the month of June when the river reached a height of approximately 1,960 cubic feet per second.

The Greeley Poudre system, by means of its tunnel and collection ditches under construction, exclusive of the possible extension to the Lower McIntyre, in other words, the Greeley-Poudre system as contemplated, will divert 23½ per cent of the run-off of the Big Laramie River and its tributaries from Colorado, that is, 23½ per cent of the Colorado water. This is based not alone upon the measurements made in the year 1912, but upon investigations conducted by Prof. Carpenter through a number of years, particularly during the years 1909 and 1910, and upon which he made a report concerning the water supply available for the Greeley-Poudre Irrigation District (3933-3957). The project, as reported on by Prof. Carpenter after

his examinations in the years 1909 and 1910, did not include a consideration of the possible extension of the system to the Lower McIntyre, but did include the system as planned and under construction. Prof Carpenter's estimate at that time, as shown by this report, was that there was 70,100 acre feet of water available for the system from the Laramie River (3936), and his conclusion as to the total flow is that at Wood's Landing, with a watershed of 404 square miles, the actual run-off for a period of eleven years averages about 14 inches after deducting the diversions by the Sky Line ditch. This means, in other words, that the Wood's Landing net flow is approximately 301,000 acre feet per annum, and therefore the diversion of 70,100 acre feet at the tunnel by the Greeley-Poudre system means 22 per cent of the total Colorado flow or approximately 23½ per cent of the net flow after deducting the Sky Line Diversions (3956-3957). It will be noticed that Professor Carpenter's figures of the amount which may be diverted by the tunnel differ from those of Mr. Field. Carpenter finds that this diversion will amount to 70,100 acre feet; Field finds 56,000 acre feet. This difference is consistent with their difference as to the total flow, Field finding that the total Colorado water is in excess of 250,000 acre feet per year and Carpenter finding it in excess of 300,000 acre feet. It is significant, however, that they agree as to the percentage of the total supply of water which can be diverted through the tunnel. Field's conclusions as to the total flow are, according to Professor Carpenter, very conservative. Lest it be suggested that the witness Field may have struck an average between Professor Carpenter and the one Wyoming witness upon this point, Mr. Meeker, we direct the attention of the court to the fact that Meeker's conclusions in this regard were never testified to until the complainant introduced evidence in rebuttal.

The complainant placed Mr. Meeker on the stand in rebuttal on May 21, 1914, to which time he had continued his measurements on the Laramie River, and some of his previous tables were enlarged accordingly. He criticises the conclusions reached by the Colorado witnesses Field and Carpenter, as a rule not specifically, but, as we understand him, for the general reason that their tables were not all based upon personal measurements and because of the possibility of error in the work of other hydrographers (4272-4278), and states that he found errors in some of the earlier records of the Laramie River at Wood's Landing, due to the presence of ice in the stream when winter measurements were taken. On cross-examination, however, he admits that Field discarded these winter records (4331). As a conclusion of his criticism, he states (4279) that he would not feel justified in modifying his own records "because they have been secured under known conditions with

hydrographic methods of much greater efficiency and accuracy than those secured in the earlier days."

He criticises Professor Carpenter's measurements taken at Boswell station, contending that the professor had taken too great a cross sectional area and too high mean velocities, while he prepared from his own measurements an area curve which he calls a standard area curve and a discharge curve which he terms a standard discharge curve. From these he prepared a discharge table which he terms a standard discharge table, Exhibits T-1, T-2 and T-3. In Exhibit T-4 he gives a comparative table of the run-off at the Colorado line for the months of April to November, inclusive, in the year 1912, based upon the published records in the 16th Biennial Report of the State Engineer of the State of Colorado, showing a discharge of 160,873 acre feet (erroneously printed in the abstract as 169,873); the figures of the witness Field showing 183,983 acre feet, and his own revision showing 165,837 acre feet for the months mentioned. It will be noticed that for the period covered by this table, that is, April to November, inclusive, Mr. Meeker is only 5,000 acre feet, in round numbers, higher than the published report of the State Engineer, although he admits that he knew that at the Boswell station the higher water passed through the three culverts which we have described and escaped measurement. The report of the State Engineer of the State of Colorado for the year 1912 was based upon the records of an automatic gauge which, as we have previously explained, was found by Prof. Carpenter to record less than the total discharge. Some corrections were made on some of the charts when this defect was noticed, but even if full correction was made, nevertheless the published record failed to include the water passing around the station. Assuming that that is the only error in the published record, nevertheless Mr. Meeker is palpably in error when he allows, on his revised figures based upon his so-called standard discharge curve, only 5,000 acre feet in addition to the 160,000 acre feet shown in the published record because, by actual measurements, Prof. Carpenter on June 4, 1912, found 500 cubic feet per second passing around the station and thereby escaping measurement; on June 11, 220 cubic feet per second, and at other dates various other amounts. Now 500 cubic feet per second is equivalent to approximately 1,000 acre feet per day, so that if the overflow of 500 cubic feet per second lasted for five days alone, it would amount to the total allowance which Mr. Meeker has given in excess of the erroneous record of the State Engineer. As a matter of fact, this overflow condition continued for more than four weeks and the total amount is indicated by the hydrograph prepared by Prof. Carpenter and previously referred to, Exhibit 158. It is approximately 28,500 acre feet.

Prof. Carpenter's measurements on the Little Laramie which were submitted to the witness are likewise criticised and two tables are put in evidence, T-5 giving a portion of the run-off for the year 1912, and T-6, a portion of the run-off for the year 1913, in connection with this criticism. We are unable to understand upon what the criticism is based, except that the witness disagrees with Prof. Carpenter.

In criticising the witness Field, Meeker states (4293) that Field, in his compilations, had used Meeker's figures when they were higher than the Colorado records and the Colorado records were higher than the Meeker records. This, however, is not borne out by Mr. Field's testimony which was to the effect that if he had used all records, his conclusion as to the flow at the state line would have been higher than he found it.

Exhibit T-7 is a continuation to the 15th of May, 1914, of the measurements made at the Pioneer Dam on the Laramie River and supersedes Exhibits B and I. This was, as will be shown later, afterwards corrected. A table, T-8, was later introduced, showing a continuation of the measurements made by the witness Meeker on the Little Laramie River, superseding Exhibit J.

In answer to a question as to his opinion as to the character of the years 1912 and 1913 with respect to the relative amount of flow of the Big and Little Laramie Rivers as a result of his measurements and observations for these two years and comparison of such records as were available for other years, the witness states:

> "Based on a review of the flow records taken only in a general way and other hydrographic information, I have concluded that the year 1912 was slightly above normal in the Laramie River basin and that roughly, the normal at Wood's Landing station or Pioneer Dam for a normal year is approximately 200,000 acre feet, and that the year 1913 was a trifle above 50 per cent of normal." (4296.)

In making this comparison, the records of the North Platte River at Saratoga, Wyoming, were considered, as heretofore stated. It will be observed that this conclusion of the witness, in so far as we have been advised of the method by which it was reached, is based entirely upon his own measurements shown by the Exhibits B, I and T-7 on the Big Laramie, coupled with a criticism, rather than a use of all other known records. Although he contended that he had reviewed other records, he failed to mention what they were or by whom made, nor how criticised. Witness admits that the automatic register maintained by the State Engineer of Colorado in the years 1911 and

1912 at the Boswell station was not registering the full amount of the discharge (4302-4303).

The estimate of Mr. Field of 12,800 acre feet per year as the normal run-off from the mountain territory along the west of the valley, discharged principally through Four Mile, Seven Mile, Cooper Creek and Mill Creek and other small streams, is criticised by Mr. Meeker with the statement that only a small portion reaches the stream, but he admits that most of this water is diverted before reaching the river and applied to lands along these creeks. The defendants contend for the purpose of this case that it makes no difference whether the water is used for irrigation along the creeks or whether the water is diverted for irrigation after it reaches the main stream. We are in no wise concerned with the location of the land under irrigation, except that it be in Wyoming (4304).

Mr. Field's estimate of 12,800 acre feet as being the normal discharge of the mountain area on the east side of the Laramie Plains is also criticised, although it is stated that Soldier Creek, Willow Creek and Five Mile Creek do contribute some water to the river. It is said, however, that from a point opposite Two Rivers northward to the Wheatland Reservoir there is practically no water from this drainage area that reaches the stream, but it is stated that this run-off is intercepted by lakes and ponds lying between the river and Black Hills and some is intercepted by the Oasis and Boughton ditches. (4306.) There is also irrigation from Soldier, Five Mile and Willow Creeks (4350). Again, we contend that if the water is intercepted either by ditches or by lakes and ponds, it in no wise negatives our argument that it is a source of supply, although it may not actually reach the Laramie River.

Mr. Field's statement, based upon the records of the State Engineer of Wyoming for 1911 and 1912, that 18,300 acre feet is discharged by Chugwater Creek, is likewise criticised because it is contended that this water does not reach the Laramie River but is used for irrigation along that stream above its mouth. Respondents likewise are in no wise concerned with the location of the irrigated area. We are the defendants in a case brought by the State of Wyoming, not by the appropriators of water on the Laramie River or on one of its tributaries. Chugwater, according to the Wyoming records, furnishes that amount of water, it is a natural tributary of the Laramie River, and we are in no wise responsible whether the water is used along Chugwater Creek or whether it is allowed to pass into the Laramie River below the Uva Station and thereby be allowed to escape (4307).

Moreover, the witness admits, on cross-examination, that a reservoir is proposed in the vicinity of Iron Mountain on

Chugwater Creek for the impounding of water from that stream (4353).

The witness then charged that Mr. Field, in his tables, had made a duplication of 17,700 acre feet in the year 1912 and 12,000 acre feet in the year 1913, but later, on cross-examination, as we have previously stated, he was compelled to correct this statement and admit that the error of 17,700 acre feet for the year 1912 was his own and also that there was no error in the 1913 record (4322).

Witness again reverts to storage and states, over the objection of defendants, that he finds the capacity of Wheatland Reservoir to be 83,400 acre feet. Based upon that capacity, that reservoir had in active storage on May 15, 1914, 58,000 acre feet; on the same date, Lake James had 21,400 acre feet and Lake Hattie 26,500 acre feet (4310). This is significant in view of the fact, as will be shown later, that at the date upon which the witness testified, the high water in the river had not yet been reached.

The witness speaks of the value of the Wheatland No. 2 Reservoir, which, because of the fact that it is built across the channel of the river, intercepts all seepage and waste waters from irrigation above (4319), and, on cross-examination, admits that, because of the topography of the country, no such reservoir is possible below irrigation on the Poudre River (4353).

On cross-examination the witness admitted that his error of 17,700 acre feet, which he first attributed to Field, ran through three tables introduced at different times, produced by himself, that is, Exhibits B, I and T-7, and that his mistake was never discovered until his criticism of Mr. Field was challenged (4324). He was also compelled to admit that an error was present in his Exhibit T-2, which he had just produced as a criticism of Professor Carpenter's measurements at Boswell station and in which he sought to give the discharge through the culverts in which the flow escaped measurement. On this table he gives the discharge at a gauge height of 3.65 as 480 cubic feet per second, whereas, according to his own discharge curve, it should have been 580 cubic feet per second, making the total discharge of the river at that gauge height 2,300 cubic feet per second instead of 2,200 cubic feet per second as indicated on the table, which, however, was corrected to meet this objection (4332).

He further admits receipt of a letter dated April 3, 1914, from Robert Follansbee, District Engineer of the United States Geological Survey, in answer to a letter of his own relative to high water measurements at the Boswell station made by the Geological Survey in the year 1911, which, inasmuch as their accuracy had been questioned, were made the subject of remeasurement on September 1 and 2, 1913, at which time Mr.

Follansbee ran levels to determine the approximate gauge height at which the overflow through the culverts would begin, and from which Mr. Follansbee found that the main overflow began approximately 1,050 feet up stream above the gauge, that the overflow would commence in the lowest overflow channel at a gauge height of 2.4, although it would not flow through the main overflow channel until it reached a gauge height of 3 (4334-4335). This measurement by the United States Geological Survey corroborates Professor Carpenter, who testified that on the night of the 30th of June, 1912, with a gauge height of 3, the overflow was imminent and that on the next morning, at a gauge height of 3.4, the overflow had occurred, so that it was apparent that the flow through the overflow channels began between the gauge height of 3 and the gauge height of 3.4 (3802). At any rate, Mr. Follansbee proves that Professor Carpenter is conservative.

Lake Hattie, according to the witness, had, on May 23, 1914, 26,500 acre feet available in storage and, although there was at that time approximately 1,400 cubic feet per second passing the Pioneer No. 2 Dam, yet no water was being stored in Lake Hattie, the reason assigned being that the superintendent had planned to finish some work on the dam which had remained unfinished in 1913, but, upon being pressed, admitted that the reservoir had sufficient water stored for use during the year 1914 (4345-4347), and that although the high water and flood stage of the river, which was late in the year 1914, had not yet been reached, in other words, was in prospect on the date upon which the witness testified, nevertheless, based upon snow reports and other information in reference to the condition of the watershed, the witness predicted that the year 1914 would be a year of very much greater flow than the year 1913 and would probably equal the year 1912 (4348). As a matter of fact, the winter of 1913 and 1914 was one of rather heavy snowfall throughout the Rocky Mountain area, although until late, the year 1913 had been a year of very low precipitation. The heavy snow came too late to be included in the measurements of the flow of the streams for 1913 concerning which Mr. Field and Professor Carpenter testified, while the witness Meeker, on rebuttal, was able to include some measurements of this flow.

THE AMOUNT OF LAND IRRIGATED.

It next becomes of interest to consider the amount of land irrigated, both in the Poudre Valley from the Poudre River and in the Laramie Plains and the so-called Wheatland area from the Laramie River. The amount of land irrigated

in the Poudre Valley is, of course, not an issue, except as it becomes so indirectly in a consideration of the necessity for water from the Laramie River, whereas, on the other hand, the amount of land irrigated in Wyoming from the Laramie River is directly in issue.

Irrigated Land, Poudre Valley.

No definite survey of the irrigated lands in the Poudre Valley was made. However, testimony of many persons familiar with the valley was taken and the figures given, it must be borne in mind, do not include the lands within the territorial limits of the Greeley-Poudre Irrigation District. The District lands amount to 125,000 acres, although there are more than that within the territorial confines of the district which are not, strictly speaking, district lands. Eliminating, then, the 125,000 acres within the district which it is proposed to irrigate but which is not now irrigated but is awaiting reclamation, we find from the evidence presented that the amount of land under irrigation in the Poudre Valley is approximately 300,000 acres. This amount, however, is what we might term the gross amount, with this explanation, that a quarter section under irrigation is called 160 acres, whereas, in truth, there may be a small portion of that quarter section devoted to buildings, barn yards, etc., which is, strictly speaking, not irrigated, if irrigation were counted by the amount of land devoted to crops under irrigation. Likewise the highways, which, of course, are not irrigated, would have to be deducted in order to get the net amount of irrigation. With deductions of this kind, the witnesses seem to agree that the actual net amount under irrigation is approximately 265,000 acres.

Mr. Wortham, the engineer of the Greeley-Poudre Irrigation District, places it at 275,000 acres (2134).

Mr. John L. Armstrong, the water commissioner for the Poudre Valley, states that the gross amount is from 305,000 to 310,000 acres; that, pursuant to the law, in 1912 he reported, by actual crop areas, 240,000 acres, but that amount did not include certain lands which were irrigated by seepage and return water nor a few very small ditches which he did not take into consideration, neither did this figure of 240,000 acres include lands covered by highways, barn yards and similar things, nor lands lying fallow; it is the net amount, determined by the actual areas devoted to actual crops irrigated by the ditches, with the exceptions mentioned, diverting water from the Poudre River. (2499.) His testimony was that at the date thereof there was an actual net amount under irrigation in the Poudre Valley of from 240,000 to 250,000 acres (2500).

Mr. J. F. McCreery, a witness for the defendants, who

had been devoting his time to the gathering of agricultural statistics and similar lines of work for the Greeley Commercial organization, testified that there were approximately 305,000 acres under irrigation in 1914 (3185).

Mr. A. A. Edwards, another witness for the defendants who had been for many years connected with irrigation enterprises in the Poudre Valley, fixed the number of acres irrigated at from 275,000 to 300,000 acres (2190).

Prof. L. G. Carpenter estimated the amount at 270,000 acres actually under irrigation (2294), and Mr. Field, the State Engineer, fixed the gross amount at approximately 300,000 acres and the net amount at from 250,000 to 275,000 acres. For the purpose of ascertaining the duty of water in the Poudre Valley, he took the figure 265,000 (3413-15, 3735).

Therefore, speaking of the irrigated area of the Poudre Valley, we believe the evidence justifies the statement that there is approximately 300,000 acres of land under irrigation, with the understanding that this includes a small portion of land in each section devoted to highways, buildings, barn yards and similar things, and in treating the question with respect to the amount irrigated from the Laramie River, the same method will be pursued, that is to say, we will speak of the gross amount of irrigation rather than the net amount as these two terms are here defined.

Irrigated Lands, Laramie Plains and Wheatland District.

For the sake of convenience, we will divide the Wyoming area irrigated by the Laramie River or its tributaries into two divisions, that lying to the east of the Black Hills, which we will term the Wheatland Tract, although, as a matter of fact, the original Wheatland tract is not all that area to be considered, and, second, lands lying within the Black Hills called the Laramie Plains.

There is no serious conflict in the testimony as to the amount of land under irrigation in the Wheatland area. The original Wheatland tract, according to the Wyoming testimony, was a desert land project, the undertaking dating from 1883 (70), and including 60,000 acres of land. In 1913, when the taking of evidence commenced, approximately fifty per cent of this was actually under cultivation (69).

M. R. Johnson, who had been for several years the superintendent of the company, placed the actual amount of irrigation at from 35,000 to 40,000 acres of land (5), whereas J. A. Elliott, another witness for the complainant who succeeded Mr. Johnson as superintendent, places the amount at 33,544 acres (168). He did, however, make an examination of a map prepared by the defendants, Exhibit 2, which showed the actual

amount of land under irrigation in this district, and testified (195) that this map "is substantially correct," and according to this map, the actual amount in the original tract under irrigation, without any deductions for roads, barn yards or similar things, and excluding the town of Wheatland, is 28,623.75 acres.

The complainant contends that as the settlement in the Wheatland tract began, they found themselves, in the absence of reservoirs, short of water during the period of low flow in the stream, that is, during the latter part of the irrigation season, and it was to supply late water that they built, first, the reservoir located upon the Wheatland tract known as Reservoir No. 1, which we have previously described, with a capacity of 7,000 acre feet, and also the large reservoir commonly called the Wheatland Reservoir and known as Wheatland Reservoir No. 2, with a capacity, according to Mr. Johnson, and Mr. Elliott, of 126,000 acre feet, and which was completed about 1900 and was supposed to have been necessary to relieve the situation occasioned by the shortage of water in the late season on the original Wheatland tract. It is significant, however, that, according to Mr. Johnson, the amount of land under irrigation at the date of the construction of the larger Wheatland Reservoir, that is, 1900, was only about 10,000 acres, and yet their reservoir capacity, in addition to the amount of water available by direct flow through the ditches, was 133,000 acre feet. It is therefore not surprising to learn that the company owning this system of works and undertaking the development of this tract of land, should later be looking about for additional areas upon which to put the vast amount of surplus water which they had available. Accordingly, two other tracts of land were filed upon, one almost immediately adjoining the original Wheatland tract on the southeast, known as the Bordeaux Tract, and another almost adjoining the original Wheatland tract on the northwest, called the Sybille or Cooney Hills tract. These last two tracts, that is, the Bordeaux and the Sybille tracts, are what is generally known as Carey Act lands. The Bordeaux tract contains 10,000 acres and the Sybille tract 30,000 acres (168-9). Although promoted by the same persons, generally speaking, as those who promoted the original Wheatland tract, they were not in contemplation at the time of the formation of the original project, nor, as a matter of fact, were they in contemplation when the Wheatland Reservoir was constructed (42). They seem to have been an afterthought, arising out of the abundant quantity of water made available by the construction of this extraordinarily large reservoir.

In the year 1913, no lands in the Sybille tract were under irrigation whatsoever. As a matter of fact, the ditch leading from the main distributing system for the Wheatland tract was

not fully completed, although the surveys had commenced in August of 1907 and construction work commenced in July, 1910, and there was under irrigation in the Bordeaux tract, according to Mr. Elliott, 1,004 acres (168), but according to defendants' survey, Exhibit 2, 451 acres. The survey for the ditch leading from the main system to this tract was commenced in February, 1904, and construction work in June, 1907.

It therefore becomes apparent that the promoters of this enterprise, in the year 1904, found themselves in a position to supply more water than the lands included within the original Wheatland tract for which the irrigation system had been constructed, needed, and they therefore, as an afterthought, began the project in 1904 called the Bordeaux tract, containing 10,000 acres and three years later, in 1907, began the surveys for the second after-project, the Sybille tract, containing 30,000 acres of land.

It therefore appears that at the date upon which the taking of evidence was commenced we have the original Wheatland tract, containing 60,000 acres of land, dating from 1883, which had in thirty years' time been developed only to the extent of fifty per cent, and while they had approximately fifty per cent yet to colonize and develop, nevertheless the same company undertakes the development of two other projects, containing, in the aggregate, 40,000 acres additional, but out of the whole 100,000 acres, dating from the three respective dates, upon which these projects were commenced, we find that they actually had under irrigation, according to Mr. Elliott, the superintendent of the company, a total amount of 34,544 acres (168), and according to the defendants' survey, 29,074.75 acres (Exhibit 2). There is no material difference in the testimony presented by the complainant or the defendants on this acreage, and it is unnecessary to indulge in any nice distinction as to whether the amount is 34,000 or 29,000. Probably the latter figure is correct, because it was based upon a definite survey, and we believe Mr. Elliott's statement to have been based upon a more general estimate.

Turning now to the Laramie Plains area, we find more difficulty in arriving at the exact acreage under irrigation. General estimates were given by various persons who testified as to the amount of land under irrigation under various ditches, but none of these are based upon a definite survey of the lands. Realizing the necessity of accuracy in this regard, the defendants, as early as possible, undertook the survey of the irrigated area in the Laramie Plains. This survey was made by a party in the field and the instrument employed was a plane table, this being an instrument of recognized merit, used by surveyors generally, including the United States Government in making both topographical and geographical surveys. The party com-

menced at Wood's Landing and worked down stream past the City of Laramie, on past the junction of the Big and Little Laramies for a distance of five miles due north, and thence back up the Little Laramie to Filmore, that being the point where the river emerges from the mountains and corresponds in a measure to Wood's Landing upon the Big Laramie River.

This survey was made of these lands in detail and an accurate map or plat was made in the field, showing every character of cultivation in the area surveyed. However, time did not permit of the completion of the plat, although the survey itself covered practically all of the irrigated lands in the Laramie plains, the only ones omitted being what might be termed the fringe on the edges of the main cultivated areas. In other words, practically all of the irrigated area in the Laramie plains was surveyed and the major portion was platted in such a way that the plat shows each tract of land, the character of cultivation, the division fences, the exterior ditches but not the interior laterals, and a classification of lands devoted to different uses. A photographic reproduction of this plat is introduced in evidence, Exhibit 114, and to this exhibit we respectfully request the consideration of the court. It will be apparent at once that this exhibit, as well as many others which were offered in evidence, could not be duplicated in the record, and we therefore pray the indulgence of the court in filing but one of each of these various exhibits.

Each page or sheet of the exhibit shows, in general, six sections. The first few sheets are the plats made of the survey near Woods Landing, and the sheets are numbered according to the numerical arrangement of the sections in their respective townships. Confusion will be avoided if the key map in the fore part of the exhibit is consulted, inasmuch as this key map will show the plat in the exhibit covering any specific section or sections desired.

For the sake of clarity, we will explain that the portion covered by the survey, but not platted, includes the irrigated area on the Little Laramie River from Filmore down to a well-known road, frequently mentioned in the testimony, called Sprague Lane. Generally speaking, the area surveyed but not platted was that portion of the territory under irrigation lying along the Little Laramie River where it runs diagonally across Township 16 North, Range 76 West, and a glance at the map attached to the answer of the corporate defendants will readily disclose to the court the area in question.

This survey was made with all possible care, although time prevented the doing of many things which defendants would have wished to do in acquiring a complete knowledge of the situation. But, with the exception of the fringes on the outside of the main irrigated area, this survey showed with the

accuracy of a survey, the total number of acres under irrigation, the total number of acres in meadow, in grain, in alfalfa, or in any other crop, and also classified the meadow lands into first, second and third class, or instead of third class, as termed by the Wyoming witnesses, irrigated pasture.

Counsel for the complainant endeavored to find inaccuracies in this plat, but, when the vast amount of land included in the detail of the survey is considered, it is significant that in only four instances was the complainant able to show even immaterial inaccuracies in this survey, none of which were at all important, and they are disclosed by a resurvey of certain specific sections as shown by the complainant's exhibits, S-1, S-2, S-3 and S-4.

This survey was made under the immediate direction of Mr. Field, the State Engineer, the party being in charge of the Deputy State Engineer, Mr. Emmett C. McAnelly, and the instrument being operated by George P. Woodhall, all of whom are witnesses for the defendants.

Upon the presentation of the evidence in chief, the complainant introduced a table, Exhibit E, purporting to show the irrigated lands on the Little Laramie River. This table was prepared by Mr. Meeker after a reconnaissance made by him and one assistant. He testifies that at times distances were measured by the speedometer upon the automobile in which he was traveling (988). Exhibit E attempts a classification of the lands in question into meadow, pasturage, oats and alfalfa, and summarizes the total as being 49,553, although Mr. Meeker in his oral testimony, placed the amount at 48,344 (983).

This table includes lands irrigated on Seven Mile and Four Mile creeks, as well as on the Little Laramie itself, and also includes 11,611 acres lying above Filmore, the point at which the stream was measured and its flow determined by the witnesses both for the complainant and the defendant. We have previously explained that this land, lying largely in what is termed the Centennial Valley, was not taken into consideration in the irrigated section for the reason that no witnesses whatsoever added the water necessary for its irrigation to the flow of the stream found at Filmore, although one large ditch, the Loback Canal, heads on the north branch of the Little Laramie River and diverts, or is capable of diverting, a large volume of water. In fact, it was used in conjunction with the Bellamy Canal as an intake into Lake James. The canal, however, along its lower course, does irrigate some lands which are included in the irrigated area by the defense, although the water taken through the canal, as previously stated, is not charged to the stream. These lands above Filmore in question are as follows, according to Exhibit E: 832 acres in Township 14 N., R. 78 W.; 178 acres in Township 14 N., R. 77 W.; 6,711

acres in Township 15 N., R. 78 W.; 2,916 acres in Township 15 N., R. 77 W., and 974 acres in Township 16 N., R. 78 W. We therefore contend that in order to be consistent, this amount of 11,611 acres must be deducted from the irrigated area contended for by complainant.

The defendants introduced a similar table, Exhibit 117, prepared by Mr. Woodhall, and based upon the plane table survey of the Little Laramie area, containing a slightly enlarged classification from that prepared by Mr. Meeker. According to the plane table survey, the total amount of land under irrigation on the Little Laramie below Filmore, the point of the measurement of the stream, is 31,341 acres. Later reference will be made to the amount devoted to the specific crops in this area.

After eliminating the 11,611 acres above Filmore and comparing Meeker's figures with Woodhall's table for the land actually in controversy, we find that Meeker shows 37,942 acres against Woodhall's figures of 31,341, but inasmuch as Mr. Meeker included in this table 2,445 acres lying on Four Mile and Seven Mile creeks, which Mr. Woodhall puts in a different classification, the actual discrepancy between the two is 4,156 acres.

Mr. Woodhall's figures of 31,341 acres irrigated land on the Little Laramie below Filmore are based upon a definite survey. Mr. Meeker's figures were, according to his own statement, based merely upon a reconnaissance.

Passing now to the Big Laramie, we find that no definite statement of the total amount of acreage irrigated was attempted by the complainant. As already stated, various witnesses attempted to give in a general way the number of acres of land under certain ditches, but no definite evidence was introduced as to the total number on the river. Mr. Meeker made a reconnaissance of the lands under the Pioneer Canal, measurements being made merely by pacing the distances. (827.) This reconnaissance occupied him and one assistant five days—August 5th and 6th and September 18th, 19th and 20th, in the year 1913. By this method he arrives at the conclusion that the total amount under irrigation under the Pioneer Canal is 11,556 acres. (824 and 844.) Furthermore, he found evidence of at least 2,000 acres having been at some previous time irrigated, but now apparently abandoned so far as irrigation is concerned.

This testimony is significant when we consider the claims made by the complainant for the irrigation of lands under this canal. The Pioneer Canal was commenced about 1879, the oldest of the larger ditches diverting water from the Big Laramie in Wyoming, and in all these years this development is represented by the irrigation, according to Wyoming testimony it-

self, of only 11,556 acres, which is more than the survey made by the defendants discloses to be the correct amount.

Before proceeding further, however, let us digress to call attention to Exhibits N and O, offered by the complainant and to which objection is made by the defendants. These exhibits purport to give the adjudicated decrees on the Laramie and Little Laramie Rivers (Exhibit N) and on Soldier and other creeks (Exhibit O). Exhibit N, being the Laramie River decree, is admittedly not a final decree. The original decree was made by the Board of Control of the State of Wyoming, from which an appeal was taken to the District Court of Laramie County and from which an appeal was taken and pending undecided at the time the exhibit was offered in evidence. The defendants object to it for further reasons which need not be discussed here except to say that we contend that it is in no wise binding upon the defendants for the very obvious reason that they were in no wise parties to it, neither could they be parties to it. However, an examination of this exhibit shows that the Wyoming authorities had decreed appropriations under the Pioneer Canal under date of April 19, 1879, for the irrigation of 49,030 acres of land, and yet their own expert is able to find only 11,556 acres.

The plane table survey included the major portion of the lands under the Pioneer system. As to the area included, we insist that our survey is definite. However, we accept without question Mr. Meeker's estimated figures where we have not measured. Taking these, added to the amount which we actually measured, we find that the total irrigated under the Pioneer Canal is 10,605.8 acres.

Mr. Z. E. Sevison, another witness for the complainant, testified to the number of acres of land under the Oasis Ditch. Inasmuch as the plane table survey did not extend to the extreme limits of the irrigation of this ditch, nor to the extreme limits of the Boughton Ditch, neither did it include the irrigation of lands under three or four smaller ditches further down the river, including the Gillespie Ditch and McGill Ditch. We have taken the Wyoming testimony, whatever it may be, for the amount of lands irrigated there. In other words, wherever we have not made a measurement, we have taken the Wyoming testimony without question, although we know that where we have measured it and compared it with the Wyoming estimate, the Wyoming evidence has always shown a higher amount than our survey proved to be correct. The result is that we find that there is in the Laramie Plains area under irrigation from the Big Laramie, the Little Laramie, Sand Creek, Soldier Creek, Four Mile, Seven Mile and Cooper Creeks, and any other sources, the total of 78,999 acres, and this figure has been arrived at by a consideration of all the testimony intro-

duced by Wyoming without question except where actual measurement disproved its correctness.

At page 2792, Mr. Woodhall, testifying in this regard for Colorado, says that the total acres of land irrigated in the State of Wyoming in the Laramie Plains from the Laramie River and its tributaries is 90,610 acres.

The abstracting of the original testimony has been possibly too brief, but it appears from the original transcript, as well as from the abstract, if analyzed, that this amount, 90,610 acres, included everything in the Laramie Plains area, even that portion irrigated on the Little Laramie above Filmore, 11,611 acres, which we insist must be eliminated from consideration. In other words, the testimony, without contradiction, shows that in the Laramie Plains area below Wood's Landing on the Big Laramie, at which point that stream was measured, and below Filmore on the Little Laramie, at which point that stream was measured, the total amount under irrigation, including the amounts under the other tributary streams such as Sand Creek, Soldier Creek, Willow Creek, Four Mile, Five Mile, Seven Mile, Cooper Creek and any other sources of supply, is 78,999 acres. Included in this are the 31,341 acres under irrigation, classified by crops, actually measured and surveyed on the Little Laramie (Ex. 117) and also 29,279.3 acres actually surveyed and measured, by plane table survey, shown according to classification of crops, under the respective ditches on the Big Laramie (Ex. 118).

The Wyoming area under irrigation in the year 1913, upon a most liberal basis for Wyoming, therefore seems to be: Wheatland area, 29,074.75 acres; Laramie Plains, 78,999 acres; total, 108,073.75 acres.

This amount of land, 108,073.75 acres, is the amount for which Mr. Field, the State Engineer of Colorado, finds that there is available for irrigation a total amount of 431,200 acre feet of water per annum as an average, less only the amount diverted from the stream by the State of Colorado. In other words, less 20,000 acre feet per annum now diverted by Colorado through the Sky Line and Divide canals and the proposed diversion of 56,000 acre feet per annum through the Greeley-Poudre tunnel. Assuming that the Greeley-Poudre system is completed, we then have Colorado diverting 76,000 acre feet per annum, leaving as a total supply of water for the lands herein designated in Wyoming, 355,200 acre feet of water as the normal yearly supply for the irrigation of 108,073.75 acres of land, or 3.28 acre feet per acre.

Later we will have occasion to discuss the question of the duty of water and will review the evidence concerning it, but it is pertinent to say here that Mr. Meeker, testifying as an expert for Wyoming, states that the duty of water on the Lara-

mie Plains is 1 acre foot per acre per annum. If Mr. Meeker be correct, all the water needed for the irrigation of the Laramie Plains area now under irrigation is 78,999 acre feet per annum, and if the same duty pertains upon the Wheatland area, then the total quantity of water needed for all the Wyoming area would be 108,073 acre feet per annum, or only approximately one-half of the total amount which Mr. Meeker, the Wyoming hydrographer, states is the normal yearly flow of the Big Laramie alone at Wood's Landing, or approximately one-third of Meeker's combined flow of the Big and Little Laramie Rivers.

Now, as will be explained elsewhere in this brief, the Wyoming law permits a maximum diversion for irrigation of one cubic foot per second of time measured at the point of diversion for the irrigation of 70 acres of land. Let it be understood that this is the maximum contemplating the most adverse conditions requiring the greatest amount of water which might be found within the state.

According to the testimony of Mr. Johnson and Mr. Elliott, ex-superintendent and superintendent of the Wyoming Development Company, the irrigation period on the Wheatland tract was approximately ninety days, but the maximum quantity of water was used for only a very short period. During the irrigation season there were times when the demand was slight. This is universally true where irrigation is practiced. No irrigator needs the maximum all of the time. There will be occasions when he will need the peak flow or the maximum quantity; at other times he may need none, and at still other times he may need less than the maximum. In other words, the demand will be variable according to the conditions of his crops and the season of the year. The irrigation season in the Laramie Plains is, by reason of the altitude, shorter than the season at Wheatland. But, for the sake of illustration, let us assume that the irrigation season in the whole Wyoming area irrigated from the Laramie River is ninety days, and let us also assume a condition which could not possibly exist—that is to say, that they required the maximum amount of water which the law gave them every minute of the irrigation season. We then would find that under the Wyoming law the 108,073 acres under irrigation will be entitled to use 2.6 acre feet per acre, or a total of approximately 290,000 acre feet per annum out of a balance of 354,700 acre feet remaining above all Colorado diversions, that is, 76,000 acre feet. As a matter of fact, according to the testimony of the Wyoming witnesses, there was actually diverted to the Wheatland lands in past years more water than the maximum amount they could legally receive under the law of the State of Wyoming.

In fixing the irrigated area at 108,073 acres and the water supply therefor, less the Colorado diversions, at 431,200 acre

feet per annum, it must be kept in mind that this water supply is the average available for all lands above and including the Wheatland tract. It does not include the flow of the North Laramie nor of Chugwater Creeks, which, if added, would make a total in excess of 450,000 acre feet per annum, as we have previously shown, but this we have not considered here for the reason that there is some irrigation along the Chugwater Creek and also some irrigation upon the North Laramie which we have not included in the irrigated area given, these two creeks reaching the main river below the Wheatland tract.

In this connection may we call attention to a colored map introduced by the complainant as Exhibit G, which purports to show by different coloring the amount of land irrigated from the Laramie River in Wyoming.

The offer of this map was objected to by the defendants, because, among other things, it is entirely at variance with all of the evidence as to the amount of land under irrigation. It is particularly noticeable that general areas are colored to indicate irrigation, whereas, as a matter of fact, such areas were not, as shown by the Wyoming evidence, irrigated. The map purports to show, according to its legend, all irrigation development prior to 1900 in green, and all irrigation development subsequent to 1900 in yellow. Not only are the areas colored green not irrigated, except in part, but the evidence introduced by the complainant shows that only a small portion was irrigated even as late as the year 1913, and the same thing may be said of that portion colored yellow, which purports to be that developed subsequent to 1900. For illustration, the whole of the Wheatland tract of 60,000 acres is colored green, intending thereby to convey the impression that it was all irrigated prior to 1900, whereas the witnesses for the complainant testified that only fifty per cent of this tract was irrigated in 1913.

We do not desire to discuss the exhibit further at this time, except to say that it is not in accordance with the evidence in any particular, and to insist upon our objection to it as shown at page 1030 of the transcript.

DUTY OF WATER.

The term "duty of water" is variable and is used frequently to designate the quantity of water which is usually applied for irrigation upon any certain tract of land or upon a certain area. Many irrigators and hydrographers use the term in this sense.

We do not so understand it and do not intend to use it in that sense here. Neither will we attempt an exact definition

of the term, except to call attention to the word "duty." Unless the word "duty" is kept in mind, confusion will arise. It implies a burden upon water in that it specifies the amount of land which a given quantity of water should adequately irrigate, rather than the amount of water which a given quantity of land receives.

Therefore, when we say that the duty of water is higher, we mean that it accomplishes a greater use. In other words, irrigates a larger acreage. The natural assumption might be that higher duty meant more water, but with the word "duty" clearly in mind, it will readily be seen that the higher the duty the less water necessary for any certain quantity of land, and the lower the duty, the more water, or, conversely, the higher duty is the greater amount of land which the water will irrigate, and the lower duty the less amount of land which the water will irrigate.

May we suggest that confusion will be avoided if the court will keep in mind a catch phrase: "Higher duty, less water."

Duty of Water in Poudre Valley.

We have previously shown that the total supply for the Poudre Valley, including the water brought into the Poudre Valley from outside sources, based upon a long series of records, is approximately 367,000 acre feet per annum (Exhibits 123 and 124) (3410, 3411), and that an average of about 110,000 acre feet per annum passes out of the mouth of the Poudre into the Platte (3411), of which probably 50 per cent is seepage water and 50 per cent original water. (Exhibit 113 and pages 2487 and 2491).

We have also shown that the irrigated area in the Poudre Valley is approximately 300,000 acres of land without making deductions for roads, barnyards, etc., but treating the 300,000 acres as the total amount under irrigation, we therefore find that about 312,000 acre feet per annum is the consumptive use in the Poudre Valley, slightly more than one acre foot per acre.

However, we do not contend that one acre foot per acre measured at the point of diversion from the river is sufficient. 312,000 acre feet of water per annum measured at the weir where the river leaves the canyon would, in the absence of use and reuse of seepage and return water, not permit of the proper irrigation of that valley, because we have the unavoidable loss of water in transit not only from the head of the ditch wherever the diversion may be, but also from the point of measurement at the mouth of the canyon to the head of the ditch.

Individual ditches have diverted and do divert very much more than that which would supply one acre foot per acre measured at the land and these have been commented on to some

extent in the brief of the complainants herein. Referring to the testimony of John L. Armstrong, water commissioner for the Poudre Valley, which shows that some small ditches diverted as much as 2.94, some as much as 3 acre feet per acre, and still others as little as .59 acre feet per acre, it is manifest that the duty of water for an area, whether that area be the Poudre Valley or the Laramie Plains, cannot be obtained by analysis of the amount diverted by any one small ditch, but must be taken either by analysis of the total amount of water with respect to the total amount under irrigation, or possibly be taken on a ditch which is typical of the whole area, using that as a criterion. Probably this last method is not as accurate as the first. However that may be, we have frequently referred to two canals in the Poudre Valley, one of them being the Eaton Ditch belonging to the Larimer and Weld Irrigation Company, the construction of which was commenced in 1879, the same year in which the Pioneer Canal was commenced, the other being the Larimer County Ditch belonging to The Water Supply and Storage Company dating from 1881. These two canals, inasmuch as they are large and in a general way run throughout the length of the irrigated area of the Poudre Valley, are, in a measure, typical.

We have definite evidence as to the duty of water, measured at the headgate, under the Larimer County Canal. Mr. A. A. Edwards, for many years the superintendent of that company, fixes this duty at one acre foot per acre for diversified crops such as are commonly raised under that ditch, measured at the headgate of the lateral leading from the ditch (2222), which would necessarily mean a higher duty at the place of application, but if fixed at the point of diversion from the river, it would be lower, because of the necessary loss in transit. The amount diverted by this canal from the river is approximately 1.2 acre feet per annum for each acre of land irrigated. (3415.) The duty under the Eaton canal, which is a canal very similar to the Larimer County Canal, is about the same. The Eaton ditch dates from 1879, the same date as the Pioneer Canal in the Laramie Plains, while the Larimer County canal is about two years junior. These two canals being among the older of the larger canals in the valley and irrigating what is, as a whole, a well developed section, are typical of the high state of development of irrigation in the Poudre Valley, and probably typical of the duty of water of the valley as an average, although some areas under other ditches require less and some more water.

The method of adjudication of priorities of right to the use of water has been explained elsewhere, but, in this connection we desire to state that the earlier decrees in the Poudre Valley are, as a rule, excessive. By that we mean that a larger

number of cubic feet per second was adjudicated to be the right of the canal than was actually needed or, at any rate, than is now actually needed for the original area irrigated. This seems to be the rule in all pioneer districts. Two causes may be assigned. In the first place, inasmuch as some of the canals in the Poudre Valley have dates earlier than 1870, at which time the science of irrigation was not as definite as it is today, it is probable that many persons making claims for these rights did not know with any degree of exactness what amount of water one cubic foot per second would produce. Doubtless the estimates given in the earlier days were very general and the natural tendency would be to over-estimate the number of cubic feet which a ditch could carry rather than to under-estimate it. But, lest we impeach too strongly the judgment of these pioneers, it is a fact that the duty of water in the Poudre Valley has been steadily and probably constantly increasing. Less water is used proportionately today than was used years ago. This tendency is very apparent. There is no conflict in the evidence concerning it, and therefore no need to refer to the specific testimony.

An examination of the evidence shows that probably every other irrigated section has undergone or is undergoing the same experience. The fact that excessive appropriations were made in Wyoming clearly appears in the testimony introduced, and there is no reason to believe that the duty of water in that area, as irrigation continues, will not increase, and in the future they will need very much less water for the irrigation of the same amount of land now under irrigation than they use today or that they need today. We use the alternative for the reason that we believe that in Wyoming they are now using more water than is necessary for proper irrigation.

Reverting again to the Poudre Valley, inasmuch as the irrigated area is susceptible of practically definite determination, and inasmuch as practically all the land under the ditches now constructed is irrigated more or less efficiently, depending upon the available water supply and the rights of the various ditches thereto, it is comparatively easy to fix the duty of water, knowing, as we do, the normal flow of the Poudre River.

As we have stated, this normal flow available for the Poudre Valley is approximately 312,000 acre feet per annum, based upon an average of thirty years' records, measured at the mouth of the canyon, and, in general, the number of acres irrigated is about 300,000 acres. Considering the use and reuse of seepage and return flow available, the amount of water used would therefore seem to be slightly more than one acre foot per acre, determined at the point of measurement on the river, and probably materially less if measured at the point of application of the water to the lands. Generally, we consider the duty of water in the Poudre Valley as one acre foot per acre, experience

showing that as an average this amount of water applied to the land will be sufficient for successful irrigation, provided, of course, the supply is so controlled as to make it available at the proper time. Therein lies one great advantage of storage reservoirs and a system of administration such as prevails in the Poudre Valley, whereby exchanges can be made between reservoirs or between reservoirs and ditches in order to get water at the proper time and at the proper place.

Great stress is made by the complainant in its brief upon the question of the time of use, the contention being that during the late summer and fall, at which time a relatively greater portion of the total flow of the Laramie River would be diverted, according to the complainant, by the Greeley-Poudre tunnel, there is a shortage of water in the Laramie River. Therefore, they contend that the diversion by the Greeley-Poudre system at that time of the season will deprive them of water which is necessary for the irrigation of their hay meadows and other crops. But, according to their own witnesses, they have been short for years at that season of the year, and we suggest that, regardless of any diversion by Colorado, they would always be short at that season of the year if they did not take advantage of the opportunity given for the storage of flood waters coming earlier in the season.

The Poudre Valley would not have been able to irrigate one-half, probably not one-third, of the amount of land now under irrigation if it depended upon the direct flow of the stream for irrigation. In the arid regions the streams always fall early in the summer and the flow, as a rule, decreases as the year advances. It is only the ditches of the earliest priorities in the Poudre Valley for which there is any available water from midsummer on, if the direct flow of the river alone is depended upon, but in all these mountain streams, in the arid area, there is a flood season, coming, as a rule, late in May and early in June, at which time water for irrigation is not needed as much as it is later in the year when the streams are lower. It is the storage of this flood water which has made the Poudre Valley what it is today. The irrigators in that section have taken advantage of every feasible opportunity for the construction of reservoirs, and practically all available water which engineering science will permit to be stored at a cost which will be justified by the returns, is now stored, or, at any rate, will be stored with the completion of the works of the Greeley-Poudre system. Are we asking anything unreasonable when we contend that Wyoming should use every reasonable means for the storage of the flood waters of the Laramie River? Have we any right to expect that the needs of mankind are to be disregarded to the extent of permitting Wyoming to deny a demand on the part of Colorado for a small frac-

tion of the Colorado water flowing in the Laramie River while Wyoming neglects to avail herself of every reasonable opportunity of conserving a supply which is available in greater quantity than her needs today and for years to come will require?

Several witnesses for Wyoming, living under some of the older ditches on the river, testified that during the summer season of 1912 they were short of water, and again in 1913 they were short of water. We have shown the very inferior quality of works by which the older ditches in the Laramie Plains divert water from the river; some had no dams at all, others had dams constructed of anything which happened to be available, rubbish, brush wood, manure, piles of loose rock, anything which came handiest, was used. Head gates in many instances, if they could be termed head gates, higher than the bed of the stream. In short, many of the older ditches in Wyoming were in no wise equipped to divert water if it was available in the stream, and it is not at all surprising that at times they may have been short of water, but this we believe to be manifest, if there had been, as a rule, a shortage of water, two things would have been apparent; in the first place, adequate diversion dams and diversion works would have been constructed, and, in the second place, there would have been a definite administration by the officers of the state whose jurisdiction it is to apportion the water according to the rights of the various ditches, and we find from the Wyoming testimony, of which we will have more to say under the head of "Administration," that all sort of regulation upon the part of the water commissioners of the various districts or other superior officers has been unnecessary, or, if not unnecessary, then it has been entirely neglected and the universal statement of Wyoming witnesses was that they took the water whenever they wanted it and as much as they wanted to the capacity of their ditches whenever it was available, without let or hindrance upon the part of any officer whatsoever and without regard to any prior appropriator.

Now, of course, the Laramie River is low from midsummer on, and it is not to be wondered at that under normal conditions some ditches depending upon the direct flow of the river might be short of water, but let us look a little farther. The complainant introduced a table, Exhibit K, purporting to give a resume of the stored water in the years 1912 and 1913, and from this statement we learn that in the year 1912 Lake Hattie commenced to store water from the Big Laramie River on the 8th day of April and from the Little Laramie River on the 4th day of June, and continued to store water from the Big Laramie River throughout not only the irrigation season, but practically throughout the year, and continued to store water from

the Little Laramie River until August 10th; that in the year 1913 Lake Hattie commenced to store water from the Big Laramie River April 25th, and continued until the 13th of June.

And from this same exhibit we find that Lake James storage commenced in 1912 upon the 21st day of April and ceased upon the 3rd day of August; that in 1913 storage commenced upon the 19th day of April and continued until the 25th day of May.

It is not surprising that ditches depending upon the direct flow of the Laramie River were short in the year 1912. As we recall it, these complaints were made by witnesses living under ditches having priorities earlier than Lake Hattie. They complained they were short of water and yet Lake Hattie continued to store without ceasing all during the irrigation season and no officer of the State of Wyoming raised so much as a protest against it. The same is true of Lake James. In the year 1913 the condition was not quite so bad, but nevertheless Lake Hattie continued to store until June 13th.

How can the complainant justify its claim that the little ditches were short of water in the face of these conditions? Either there was no shortage of water and the little ditches received their supply, regardless of Lake Hattie's storage, or there was a palpable violation of the law upon the part of the Laramie Water Company, the owners of Lake Hattie. We have previously shown that 1912 was approximately one of normal water supply. If Lake Hattie can store during the irrigation season of 1912, we can see no reason why it should not store during the irrigation season in any normal year. Let us suggest that in the Poudre Valley no such condition of affairs would have been tolerated for a single instant. In Colorado, no reservoir is allowed to store as long as any ditch, be that ditch either senior or junior to the reservoir, demands the water for direct irrigation. The reservoirs in the Poudre Valley are permitted, and this has been the custom since reservoirs were built there, to store only when there is a surplus above the amount needed for direct irrigation by all ditches, and many a Poudre Valley reservoir has been compelled to forego storage of water which was available in the Poudre River because a demand was made for that water by ditches using water for direct irrigation on the lower South Platte. We do not state this as a proposition of law, but as a question of fact, as a condition under which storage in the Poudre Valley has been accomplished, and the rule of practice to grant the junior ditch water for direct use against a senior reservoir has been the established rule of administration in Colorado, although it is possible that it may ultimately be otherwise determined as a matter of law.

Duty of Water, Wheatland Area.

The duty of water on the Wheatland area, in so far as the application to the land is concerned, should not be abnormal. So far as developed, the area is devoted to somewhat diversified farming. The average altitude is approximately 4,700 feet above sea level, and we see no reason why conditions there should not follow the general rule of irrigated districts, and we have no doubt whatsoever that experience will disclose that the duty of water will be increased from year to year. However, no shortage of water is apparent upon this area, at any rate, since the construction of their reservoirs. Rather, they have had more water than they needed.

We have stated that the original Wheatland tract was a Carey Act project, and in the early history of that project we find that the promoters actually turned water loose upon the bare naked prairie, claiming thereby that they would increase the natural growth of the prairie grass. These were not hay meadows, they were but prairie lands which are common to the area to the east of the Rocky Mountains. No further explanation was made. We do learn, however, from their own testimony, that they had considerable difficulty in securing the approval of the Government and that for a number of years their patent or patents were withheld. We are prone to wonder whether the reclamation required by the law of Congress, commonly known as the Carey Act, as a prerequisite to patent, was claimed to have been accomplished by pouring water upon prairie lands, but, dismissing that, it is apparent that they had more water than they needed for legitimate irrigation.

We learn that they have approximately 29,000 acres under irrigation, but let us take their own estimate, in round numbers, and call it 33,000 acres under irrigation, including the small amount in the Bordeaux tract. M. R. Johnson, at one time superintendent of the system, testified (91) that the irrigation season ordinarily is from 90 to 100 days, during which period the water is applied more or less constantly and in greater or less amount, depending upon the needs of the crops. This is confirmed by the testimony of Mr. Elliott, the superintendent succeeding Mr. Johnson, who also testified (170) that in the year 1912 100,000 acre feet of water was used for the irrigation of this amount of land, and, nevertheless, they had 40,000 acre feet left in the Wheatland Reservoir at the close of the season. In other words, they used three acre feet per acre that season, whereas, under the Wyoming law, if they had applied the full maximum amount which the law permits, continuously without diminution for a period of 90 consecutive days, they would have diverted only approximately 85,000 acre feet. It therefore appears from their own testimony that the

Wheatland people diverted, during the year 1912, 15,000 acre feet more than the maximum permitted by the law of Wyoming for the most extreme conditions in that state. No such demand as that permitted by the maximum amount under the Wyoming law is possible. That tract manifestly does not need the maximum quantity of water allowed throughout the whole irrigation season.

Mr. Johnson testifies (94) that since the original construction of the tunnel and the diversion of water through this system, they have never been interfered with by the authorities of the state, but have taken water when and where they would, with only one exception and that was in the year 1911, when they were directed to allow some water to pass their diversion dam for the use of persons below. Again, we learn from the testimony of Mr. Elliott (212) that the net distribution of water to the Wheatland lands in 1912, was from 2.6 to 2.7 acre feet per acre, determined by actual deliveries at the head of the laterals leading to the lands. It is therefore apparent that the Wheatland system has had available not only an excessive amount of water, part of which, in a normal year it was unable to use, but also the amount distributed, measured at the head of the lateral ditches, amounted to from 2.6 to 2.7 acre feet per acre, or more than two and one half times the amount of water correspondingly used in the Poudre Valley.

Mr. Field testifying for the defense, in reviewing the tendency heretofore mentioned, concerning the increase in the duty of water as irrigation developed, particularly where necessity required it, says (3572) that he would expect that if economy ever became necessary in the Wheatland district, the duty of water would not exceed one and one half acre feet per acre, measured at the head gate of the canals, and that there need be no increased diversion over the amount at present diverted for the ultimate irrigation of the entire unirrigated land now proposed to be irrigated.

Duty of Water, Laramie Plains.

When we consider the Laramie Plains, we again find more difficulty in arriving at the true conditions. This area seems to be abnormal from many view points. No attempt whatsoever was made in the presentation of the case in chief to establish a duty of water in this area, but from various witnesses we learn that the principal crop in the Laramie Plains consists of native hay. The average altitude of these plains is about 7,100 feet above sea level, and the history of the area shows that it has failed to become a farming region. In so far as the area is irrigated, by far the greater portion, in fact almost all, is devoted to the growth of native hay. The testimony shows

that the practice in the irrigation of these hay lands is to apply the water copiously, to flood the meadows and keep them constantly flooded until it became necessary to shut off the water in order to permit the ground to dry sufficiently to permit mowing the hay. Under this system, there are few lateral ditches, but the water is applied until the whole country devoted to hay meadows is flooded, advantage being taken of draws, depressions and so forth, for the distribution of the water. On the Little Laramie the water is spread out through a number, five or possibly seven, different channels of the river, dams of manure or any other convenient substance being placed here and there to divert the water out of the channels.

The complainant, in its brief, says that this is the only sort of irrigation possible under the circumstances; that inasmuch as hay meadows are not cultivated, they do not lend themselves to systematic irrigation as where the water is distributed through the furrows in cultivated fields. To a limited extent this may be true, yet it does not excuse the fact that the most primitive methods have always been used and still prevail for the irrigation of these hay meadows on the Laramie Plains, and it is a fact that for weeks these lands are practically swamps, saturated until a remarkable condition described by one Wyoming witness appears. This witness testified that boulders appearing upon the lands so brought under irrigation, in time sink beneath the surface of the ground and disappear. We are unable to give, from the evidence introduced by the complainant, a definite statement as to what amount of water was actually used, much less the amount of water required in the irrigation of this area, but from beginning to end of the evidence in chief, this fact appears, that water was used just as freely as the irrigator wished and the supply permitted. It was a copious flooding, and that practically at no time in the history of the Laramie Plains had there ever been any administration of the water by the water commissioner or any other official. The few exceptions will be noted later.

However, Mr. Meeker, in his Exhibit J, followed in rebuttal by Exhibit T-8, estimates the amount of water distributed to the ditches between the No. 2 Dam and Two Rivers on the Little Laramie, at 17,245 acre feet in the year 1912. Inasmuch as there is, according to the defendants' plane table survey, 31,341 acres in this area, Mr. Meeker's figures, if correct, would mean a duty of water of approximately .55 of an acre foot per acre, which, upon its face, is absurd. The evaporation from the surface of the soil would even approach this amount. Moreover, it is absolutely inconsistent with his amount distributed to the Pioneer Canal, for the same year, which he gives as 17,703 acre feet for the year 1912, Exhibit B. The Pioneer Canal, in large measure, irrigates native hay lands, similar to the irri-

gation upon the Little Laramie, and yet Mr. Meeker was able to find by his reconnaissance only 11,556 acres under the Pioneer, and this is reduced by our plane table survey to 10,605 acres. It would therefore appear that his duty of water on the Pioneer, if his estimate of the flow of the river is correct, is approximately 1.6 acre feet per acre. His Little Laramie figures and his Pioneer figures cannot be harmonized, but that is not to be expected, because we know his estimate of the flow of the stream is entirely too low, and that 1.6 acre feet per acre is only a fraction of the amount of water actually used under the Pioneer Canal and other ditches in the Laramie Plains area, but let us take Mr. Meeker at his own figures for a moment. He testifies on rebuttal that the normal flow of the Big Laramie at Wood's Landing is 200,000 acre feet per annum, that the Little Laramie is approximately fifty per cent of this amount, measured at Filmore. In other words, he estimates the total in the two streams to be 300,000 acre feet per annum, without allowing anything whatsoever for any other sources of supply, although we know there are such. Let us for a moment consider only the 300,000 acre feet. Now let us deduct 100,000 acre feet for the excessive amount which the Wheatland people contend they have used. That leaves 200,000 acre feet net for the use of the Laramie Plains. Now, if Mr. Meeker's figures be correct, in his Exhibits J and T-8, that 17,245 acre feet of water was distributed in the normal year 1912, for the irrigation of 31,341 acres of land on the Little Laramie between the Lake Hattie No. 2 Dam and Two Rivers, thereby establishing a duty of water at .55 acre feet per acre, he has water enough, according to his own estimate of the total flow, after deducting 100,000 acre feet for Wheatland, to irrigate 363,000 acres of land. Or, on a like basis, if the duty of water as established under the Pioneer Canal by Exhibit B and others following it of 1.6 acre feet per acre is correct, he has water enough for the irrigation of 125,000 acres of land, yet all the land now under irrigation in the Laramie Plains, is, as we have shown, 78,999 acres below the points of measurement on the two streams. Assuredly Mr. Meeker is wrong either in the total amount of water available in the two streams, or in his duty of water, or, what is probable, he is wrong in both.

Other analyses of Mr. Meeker's figures show additional inconsistencies.

As heretofore mentioned, the defendant showed that the amount of water in the Big Laramie at the state line is, according to Mr. Field, approximately 250,000 acre feet per annum; according to Mr. Hedke, approximately 300,000 acre feet, and according to Prof. Carpenter, in excess of 320,000 acre feet per annum. We also showed the exact number of acres under irrigation as heretofore explained, and we showed the

lack of administration, the go-as-you-please system of the distribution of water in Wyoming, the absence of adequate diversion works, in short, primitive methods, arguing an abundant supply of water.

On rebuttal, Mr. Meeker, the Wyoming expert, took the stand again and of necessity was compelled to modify the conclusions deducible from his tables previously introduced in evidence. Let us see what he did.

In the face of his own tables showing .55 of an acre foot per acre as the duty of water on the Little Laramie and 1.6 acre feet per acre under the Pioneer Canal and various other amounts in different locations on the Laramie Plains, and in the face of the fact that all of the evidence showed wasteful conditions in the use of water, he testified (4317):

> "From my records and experience, the duty of water diverted from the Laramie River between Pioneer Dam and Two Rivers station is approximately one acre foot per acre. This includes copious flooding of the meadow lands and irrigation of the pasture land adjacent to the river. If all the lands irrigated between these stations were included, the duty of water would be higher."

Moreover, with respect to the lands on the Little Laramie River he placed the duty of water also at one acre foot per acre. This particular testimony seems to have been omitted in the abstracting, and we therefore take the liberty of quoting the original transcript, page 4320:

> "Q. I neglected to ask you if you could state approximately the duty of water realized between Lake Hattie No. 2 Dam on the Little Laramie and Two Rivers. A. That is also approximately one acre foot per acre per annum.
>
> Q. Is the general character of the irrigated crops grown there similar to that in the Big Laramie Valley? A. Yes, sir.
>
> Q. Including meadow lands and irrigated pasture? A. Yes sir, and on account of the copious application and large return waters, there is also a large re-use of water between the two points, which accounts for the high duty.
>
> Q. What can you say of the relative rapidity of the return flow in that portion of the stream? A. That is also very rapid."

From this it appears that Mr. Meeker, possibly in order to make his estimated total flow in the river coincide with the number of acres which he claimed to be irrigated, places the

duty of water at this amount, one acre foot per acre, for practically all of the irrigated area of the Laramie Plains.

Now, on this basis, Mr. Meeker finds water enough in the Little Laramie and Big Laramie, without considering smaller tributaries, for the irrigation of 300,000 acres of land after the amount at present diverted by Colorado is eliminated, or enough water for the irrigation of 244,000 acres after Colorado has diverted the additional 56,000 acre feet which we expect to take through the Greeley-Poudre tunnel. Wyoming has, according to the testimony, a total of 108,073.75 acres now under irrigation in the Laramie Plains and in the Wheatland area. Apparently the expert testifying in this regard in behalf of the State of Wyoming, and, as a matter of fact, the only witness in behalf of the State of Wyoming who attempted to testify as an expert on the question of water supply and the duty of water, finds that according to his established duty of water, he has, after Colorado will have made its additional diversion herein sought to be enjoined through the Greeley-Poudre tunnel, water for the irrigation of 135,926.25 additional acres of land above the amount now irrigated. It is true that Mr. Meeker did not testify to the duty of water on the Wheatland area, neither has any other witness except as we have heretofore reviewed it. If it be contended that the duty of water on the Wheatland area is lower, this acreage would, of course, have to be reduced accordingly.

Mr. Field, State Engineer of Colorado, found that from the total supply of water available for all lands above and including the Wheatland tract, after deducting all Colorado diversions, including the 56,000 proposed through the tunnel, that there remains for the Wyoming lands 373,500 acre feet of water as a normal yearly supply. If Mr. Meeker's duty of water be correct, then, after Colorado had done everything which physically can be done toward the diversion of water from the Laramie River, there remains, with the Wyoming supply added, enough water above the Wheatland tract to irrigate 373,500 acres, and if Prof. Carpenter be correct then there will remain water sufficient to irrigate in Wyoming 400,000 acres or more.

ADMINISTRATION OF WATER.

Fundamentally the laws of Colorado and Wyoming, with respect to irrigation, are the same. As a matter of fact, the Wyoming laws were patterned largely after the laws of Colorado, and probably the chief difference lies in this: that in Wyoming the water is appurtenant to the land; as we understand, it is adjudicated for the irrigation of a certain piece of land. In Colorado, the water is not appurtenant to the land.

In Wyoming the prospective appropriator applies to the executive officers for a permit, which is granted him if there is, in the judgment of the State Engineer, sufficient unappropriated water in the stream to supply his demand. The appropriation or the priority of appropriation dates from the time this application is filed, and later on the adjudication or decree is made by the Board of Control, consisting of the State Engineer and the Division Superintendents of the state. From this board an appeal lies to the courts.

In Colorado no permission is necessary to initiate a right, but the appropriator files his map and statement with the State Engineer, formerly with the county clerk and recorder of his county, and proceeds with his construction regardless of the amount of unappropriated water in the stream. If he proceeds with diligence, depending upon the circumstances, he is entitled to a decree, but this decree is rendered by the District Court having jurisdiction.

In both states the chief executive officer having jurisdiction of the administration of water is the State Engineer. The states are then divided into divisions, over each division there is a division engineer, or, as termed in Wyoming, division superintendent, and again divided into water districts, each water district being under a water commissioner.

In Colorado every ditch diverting from the stream is required to maintain an adequate headgate by which the water may be shut out of the ditch, and a definite measuring weir in which the water flowing in the ditch can be measured, and each reservoir is required to maintain a gauge indicating the depth of available water in storage.

Poudre Valley.

In considering the administrative methods employed in the Poudre Valley, we wish to refer generally to the testimony of John L. Armstrong, appearing at pages 2454 to 2548, inclusive, and of A. A. Edwards, a man of wide experience in irrigation matters, pages 2180-2258. Mr. Armstrong had been for twenty-four years out of thirty-one, water commissioner or acting water commissioner of Water District No. 3 of the State of Colorado, which includes the Poudre Valley, and he gives in detail the system under which his duties are performed. The inflow from other watersheds into the Poudre River is observed and measured constantly by deputies, and the flow of the stream constantly observed. Each of the larger canals maintains an employe whose duty it is to regulate the gates of the canal, and the commissioner is in constant touch with these headgate keepers by telephone. In fact, before public telephone lines became general in the Poudre Valley, private lines were built in part for this purpose. The commissioner makes it a

practice to notify each headgate keeper of the water available for each respective ditch twice a day, and oftener if there is a radical change in the stream flow. Ditches are watched with minute care in order to secure the proper distribution of water and the prevention of waste.

Counsel for the complainant refer to the methods employed by the water commissioner in this regard as being those of a fugitive from justice, because of his surreptitious visits to headgates, etc.

Methods of exchange between upper and lower ditches or ditches and reservoirs have been systematized. For illustration, an upper ditch of junior priority may have a reservoir located at some place which renders it unavailable for the irrigation of the lands under that ditch. This reservoir is filled when water is available for it. During the irrigation season this ditch may take the water from the river to which an earlier but lower ditch is entitled and from its reservoir supply a sufficient amount of water for the needs of the earlier but lower ditch. Many other illustrations of the exchange of water might be given, but it is unnecessary to say more than that by reason of this general system the highest possible use of water is accomplished and the irrigation of far more land is made possible than if such a plan were lacking.

Comment has been made that some ditches in the Poudre Valley were not thus regulated and scrutinized, but these, as described by Mr. Armstrong, are small ditches having early priorities, lying close to the river and these, or at least some of these, the witness states it is not necessary to regulate for the reason that they can use only so much regardless of the amount they divert, and that the surplus returns immediately to the stream. It must be borne in mind that these ditches under these peculiar conditions are the exception to the general rule, and when we state that the larger ditches in the Poudre Valley are many miles in length, the court will at once understand the difference and the reason for the difference. For illustration, the Poudre Valley canal as extended to irrigate the lands of the Greeley-Poudre Irrigation District is more than one hundred miles in length. The Larimer County canal, frequently referred to in the testimony, is something over eighty miles in length; the Eaton canal about the same length, and others also of great length. Practically all of the canals in the Poudre Valley have modern, efficient diversion works, those of later construction being mostly of concrete or masonry, older ones being timber construction. There are a few exceptions to this rule.

This administrative system in the Poudre Valley is not the accomplishment of one day, but it is the development of possibly forty years experience in irrigation, during which

period there were several times at which it was thought that the limit of irrigation had been reached in the Poudre Valley, but successive years have shown that the duty of water constantly increased, that the necessity for water produced more efficient methods both in distribution and in application, and that possibly the Poudre Valley has not yet attained its ultimate development in this regard.

Administrative Methods in Wyoming.

Let us contrast the Poudre Valley in this regard with the Wyoming area under consideration. The Wheatland system is relatively new, and the diversion works modern. The same thing may be said of the Lake Hattie System and the Lake James System, possibly some others. But these are the exception to the rule in Wyoming, where we find that the most primitive conditions still prevail and ditches are largely without dams, without adequate head gates and no definite system of administration has ever been employed. To definitely show this lack of development, or rather, to show these primitive conditions, the defendants caused to have taken a photograph of the head gate of every ditch diverting water from the Big and Little Laramie Rivers on the Laramie Plains area. These photographs are introduced in evidence as Exhibit 115, and speak more forcibly than any verbal description which we could make.

Let us see what the Wyoming evidence discloses as to the administration of water by the officers of the state having jurisdiction of the subject-matter.

Mr. Elliott, superintendent of the Wheatland system, testified that neither the Board of Control, the State Engineer, the Division Engineer or the Water Superintendent or any other water official had ever required them to release water held in storage in either of their reservoirs, nor had in any way interfered with either the storing or the diversion of water in that system (194).

His predecessor, Mr. Johnson, however, testified, as we have previously stated, that in 1911 they were required to allow some water to pass the diversion dam. In other words, they were not permitted to take it all.

Another witness, Mr. Mortimer N. Grant, was produced by the complainant. It seems that Mr. Grant, a civil engineer, was water commissioner on the Big and Little Laramie Rivers and their tributaries in Wyoming in the year 1913, and his testimony is so pertinent to the subject now being discussed that we feel justified in quoting at length from the abstract. This testimony appears at transcript pages 1276 to 1289:

"I am a civil engineer. In 1913 I was Water Commissioner for that district in Wyoming covering the Big and Little Laramie Rivers and their tributaries from the state line down to a point about a mile below the junction of those two rivers.

On the Big Laramie complaints about water were made that year, the latter part of May or first of June, by the Wyoming Development Company, and complaints were made about July and August by four or five ranchmen. On the Little Laramie more complaints were made, mostly down towards the mouth.

The complaints on the Little Laramie were chiefly in July and August.

I encountered quite a bit of trouble in distributing water among the users from the Little Laramie in 1913 because of the low stage of water in the Little Laramie River. It practically disappeared before it got down to its mouth. I took a vacation and ended my duties that year about Sept. 1st."

Cross-examination by Mr. Fred Farrar:

"During the period mentioned, my headquarters were at Laramie. During July and August I was in the field the major portion of the time. My trips generally consisted of the following: I went up to the head of the Little Laramie, down the Big Laramie and back up the Little Laramie. I think I made seven complete round trips, aside from side trips. That is only approximately, I don't know the exact number of trips. The Wyoming Development Company, mentioned, which made complaint, is the Wheatland Company. No complaint was made against Lake James, there was one complaint made against Lake Hattie. I don't remember the exact date, it was about June 8, I imagine. In the year 1912 I think there was a man named Wilson acting as water commissioner on the Little Laramie, I don't know who was on the Big Laramie, I understand there was a commissioner. Previous to that year there had been water commissioners appointed, but they have never been out in the field to amount to anything. The water commissioner, as a rule, only goes out in the field when called. Otherwise he does no actual work."

Cross-examination by Mr. Charles F. Tew:

"I was called on to measure water. I usually did all my work with a current meter. I was not making reports for the state engineer's office. The current meter

was employed because there were no measuring devices in the Big Laramie ditches that were adequate. The practice prior to 1913 on both the Big and Little Laramie Rivers, so far as I know, has been to employ the water flow of the stream without the assistance of any measuring devices in the ditches. The only time the water commissioner had been employed on the Big and Little Laramie Rivers to my knowledge was when there was complaint by water users. I think that was the practice all over the state. I think in 1912 the water commissioners on the Big Laramie were put on a salary and supposed to be in the field all the time.

There have been differences prior to 1912. In 1912 there was no complaint that I know of. There was a man employed as commissioner but I have forgotten his name. I never heard it mentioned. With the exception of the Pioneer dam on the Big Laramie River and the Lake Hattie Supply No. 2 dam on the Big Laramie River, the dams all up and down the river are what you would ordinarily call ranch ditch or beaver dams, consisting of brush and the like. Each freshet modifies the dams somewhat. There were no set or fixed conditions at the head of any ditch whereby former measurements would be a proper guide as to the inflow into the ditches. It would be impossible for a person on either river in the year 1913 to state, without a current meter or measuring device, what amount of water was being taken into any ditch at any time. All that could be reached without the use of instruments would be a poor approximation. From conditions I saw on the ground, I imagine that those conditions had existed and prevailed always. With the exception of the Bellamy canal diversion and the Lake Hattie No. 2 diversion on the Little Laramie, the remainder of the dams were of brush and the measuring devices lacking the same as on the Big Laramie. The Bellamy Ditch is the intake for James Lake. From what I have seen on the Big Laramie, it is as I have described. When I made these trips I generally went to the several headgates. I established rating stations and put in gauges on several of the ditches. I traveled up and down the river with a team and went up as far as Wrights and stayed there and then went around the country and crossed over to Lake Hattie and Sodergreen's. I measured pretty near all of the ditches from time to time. I put in staff gauges to see what was flowing in. On the Little Laramie River there were quite a number of complaints made in July and August. Rating stations were placed in only the biggest ditches. There

were no particular clashes that I had any trouble over. I either shut them down a little bit or opened them up accordingly. There were some cases where there were no headgates. The only place I had any trouble was on the Big Laramie, and there I sometimes shut down the gate or throw manure in it, probably old gates were in, but they would leak.

Most of the ditches on the Big Laramie River are what you might call two-story ditches; that is, they were above the bottom of the creek so they would have to have a dam to divert at low stages. At high water they got all the water they needed. They start to drawing water for these meadows in the higher states in June. The whole territory along both streams is used as a hay ranch country. The irrigation season is close onto ten weeks for hay. They generally use their water right up to the time they cut their hay, which is about the middle of July. Some may start in later than the first of May to irrigate, but they generally irrigate from the first part of May to the middle of July. There was clamor of shortage of water but they gave us no trouble; the flow could be regulated by using manure as described. The Big Laramie River got down pretty low in the latter part of July and August, with a manure and rock dam you could divert all the water.

There were a number of what I called two-story ditches. The average ditch does not cut the bottom of the river. A great many of the ditches are two-story. With a two-story ditch the irrigator obtains all the water he wants when the river is high, but at low stages it requires a dam. At such times the user goes to the head and throws some obstruction in the stream to suit his desires. The change of elevation of water of course makes a change of intake capacity in these two-story ditches. The irrigators settled their questions themselves; they probably would be disgruntled, but didn't bring complaints to my office. From the conditions I noted there on the channel of the river, it looked to me that the same conditions prevailed as they had in the past. It is also true that each high water flow modifies these dams to some extent, washes them out and they have to be re-installed. While the dams have been changed from time to time, the ditches have remained unchanged."

Cross-examination by Mr. Delph E. Carpenter.

"Lake Hattie evidently had been receiving water after the ice had passed out of the river in the spring. I cannot tell you the amount of water in Lake Hattie,

I haven't the data with me. They had diverted only from the Big Laramie River in 1913, but I did not keep a record of the flow. I read the gauge every time I was there. They ceased running water into Lake Hattie on about June 8, 1913, and I think that Lake Hattie was about half full in addition to all the dead water space in the lake. I would say that they had approximately 20,000 to 30,000 acre feet of water available for irrigation in Lake Hattie.

I did not know that they were running water out of Lake Hattie and wasting it into Big Basin until about the first of September. The only time I knew of their running water down into Alkali Lake or Alkali Basin was when they tried out the canal once or twice. It only ran for a day or so at that time. I heard that at a later time when Mr. Goldsborough had some prospective land buyers out there he ran water for several days and wasted it into Big Basin. I did not go to look it up. I think there was considerable water left in Lake Hattie when I resigned, about September 15. My active duties as water commissioner ceased September 1st, after that date I was only subject to call.

Water was diverted through a ditch known as Sodergreen's high line ditch in the summer of 1913. That is a recent ditch; a recent appropriation. The Sodergreen high line was shut off in June some time, with the exception of one or two days' run.

I cannot say how much water was diverted into Lake James during the summer of 1913. I kept no record.

I had the record of flow and gauge height of Lake Hattie from Mr. Meeker; the only gauge heights I took from time to time were those I had to take when I was there to check his.

The first complaint I received was from the Wyoming Development Company, directed against Lake Hattie enterprise. There was, I imagine, about a week I didn't get any records on the steel bridge at Lookout. I think Mr. Elliott went up and measured the water at the steel bridge and made complaint at that time. His complaint was that there was insufficient amount of water coming down to the Wheatland Reservoir to satisfy their rights. I turned the water down from the Lake Hattie diversion because Lake Hattie was what was called a flood water right to fill Lake Hattie, and Wheatland was prior to Lake Hattie. In other words, the Lake Hattie enterprise was a very recent one, more recent than the one below.

On both the Big and Little Laramie Rivers it is practically physically impossible for any water commissioner to properly apportion the waters with the appliances that exist at the present time. The Little Laramie is better as to headgates than the Big Laramie. Everything is so crude on both rivers that an apportionment according to the legal rights of the parties is practically out of the question, unless one has a current meter to measure it, and then it is a matter of a good deal of labor to try to regulate the water. Each rating consumes considerable time and expense. So that, for the orderly administration of that water supply the conditions are not there. The accuracy of the ratings depends on the percentage of errors you expect to allow. You can't get them down to any fraction of a foot or so, on any of those ditches, without cleaning out the channel, but it is almost as good as a measuring flume ordinarily. The Big Laramie is passing through the same history that all streams have passed through until a certain pressure is brought to bear on them, when they have to put in certain devices to regulate the water.

The James Lake enterprise is a comparatively recent one."

This testimony from a Wyoming witness clearly proves every contention which defendants have made to the effect that primitive methods still pertain in the Laramie Plains area; that there has been practically no distribution of water by the officers of the state, but, on the other hand, that go-as-you-please methods have and still do prevail.

Methods of administration, distribution and application of water between the Poudre Valley and the Wyoming area are further contrasted in the testimony of Mr. Field, the State Engineer of Colorado, more particularly at pages 3562 and 3576, inclusive.

Exhibit 115 is a series of photographs showing the diversion works of practically all ditches on the Laramie Plains. A key map in the front of the album shows the location of each scene.

COMPARISON OF AREAS.

The defendants approached the trial of this cause with the feeling that the court would desire the fullest knowledge of all questions pertinent to the direct issues, and to this end they have undertaken the production of much evidence tending to show the difference in the two areas—both the difference in develop-

ment and the difference in possibilities, and, in reviewing the evidence, we are going to adopt a statement made by Dr. L. H. Bailey, a witness produced by the defendants, to the effect that the two areas are to be contrasted rather than compared.

When we speak of the two areas, it is possibly best that we define our meaning. We have heretofore admitted that the Wheatland area, lying to the east of the mountains, with an elevation of approximately 4,700 feet above sea level, should be a normal agricultural district, that is, normal based upon conditions pertaining throughout the arid west, eliminating any exceptional areas.

The growing season at Wheatland should be comparable with the growing season in the Poudre Valley, and, inasmuch as during the thirty years which have elapsed since the inception of the project, various crops have been grown, we expect that the future will demonstrate that the major portion of the Wheatland tract is a fair agricultural district capable of producing hay, cereals, garden truck, and, possibly, sugar beets and potatoes, although the evidence discloses that the culture of sugar beets heretofore has been not highly successful, but we have no particular criticism to direct to this area from an agricultural standpoint, and the contrast which we wish to draw will be, therefore, limited to the Poudre Valley and the Laramie Plains. At the outset we wish to explain that the lands included within the Greeley-Poudre District are nothing more nor less than an extension of the already reclaimed lands of the Poudre Valley, differing in no material respect from the developed lands immediately adjoining on the west, and the history of the Poudre Valley under irrigation gives a very fair indication of the development to be expected in the 125,000 acres constituting the Greeley-Poudre District, if water is available for its irrigation.

The distance between the Poudre Valley and the Laramie Plains, at their nearest points of approach, is not to exceed fifty miles in an air line. However, the trend of the valleys is, generally speaking, at right angles to each other. Nevertheless, while only these few miles intervene, we find the greatest divergence in practically everything except distance. The average elevation of the Poudre Valley is between 4,500 and 5,000 feet above sea level. The city of Fort Collins, lying about six miles immediately outside the foothills, is 5,000 feet, while the city of Greeley, some 25 miles further down the Poudre River, is about 4,500 feet. Between the Poudre Valley and the Laramie Plains lies a range of mountains heretofore described as the Green Mountains in Colorado and known as the Black Hills or the Laramie Mountains in Wyoming. This is a relatively low range and the Laramie Plains, lying within or to the west of this range, constitutes but one of a number of high mountainous plateaus enclosed by the different parallel ranges constitut-

ing the Rocky Mountains. A similar area in Northern Colorado is called North Park. Passing southward through Colorado we find three more of these so-called parks or high mountain plateaus, they being, in turn, Middle Park, South Park and the San Luis Valley, and each one is comparable in many respects to the Laramie Plains, in that, as a rule, the altitude is so great as to forbid agriculture in the accepted sense of the word, but, on the other hand, native hay is rather abundantly grown and the areas have always, since their earliest settlement, been devoted to livestock raising. There is some difference due to latitude and the evidence shows the San Luis Valley, in the south central part of the State of Colorado, with an altitude of about 7,500 feet above sea level, has the advantage of lying approximately 400 miles to the south of the Laramie Plains, and on that account enjoys a somewhat warmer climate than does the Laramie Plains, but that, nevertheless, in this San Luis Valley, agriculture has largely been confined to the hardier plants, owing to the brevity of the growing season and the prevalence of late frosts in the spring and early frosts in the fall.

The Laramie Plains has an average elevation of approximately 7,100 feet above sea level, the city of Laramie, lying about the center of the valley, being 7,187 feet above the sea. This difference in altitude, that is, 7,100 for the Laramie Plains and approximately 4,700 for the Poudre Valley, is the principal reason for the agricultural contrast in the two areas.

The complainant, in its brief, with some irony, comments upon the amount of evidence devoted by the defense to the beauties of the Poudre Valley and admits that it is an area of high agricultural development, and also admits, in so far as we can expect admission on this point, that the Laramie Plains is handicapped by a cold climate and that its agriculture must be of a very limited sort. We believe that the history of these areas and their development, or lack of development, is a very clear indication of their possibilities. While it is true that, generally speaking, the areas included within Colorado and Wyoming began developing about the same time, nevetheless Wyoming had the advantage of the earlier settlements and the earlier transcontinental highways, the only possible exception being some Spanish settlement in the extreme southern portion of the State of Colorado, but the very early wagon routes across the continent passed across what is now the State of Wyoming, and Fort Laramie (distinguished from Laramie City), at the junction of the Laramie and North Platte Rivers, has been a point of settlement of marked historical interest from the earliest days in the settlement of the West. This point was established, probably as early as 1844, as a fur trading station and was later occupied as a garrison for U. S. troops. From here fur traders operated probably throughout all of the surrounding Rocky Mountain region, going as far south as the

Poudre Valley in Colorado. In the 60's the Union Pacific Railroad, building from Council Bluffs, Iowa, to Ogden, Utah, followed rather closely the old Overland Trail across the range of mountains to the east of the Laramie Plains at a point known as Sherman Hill, reaching the city of Laramie, where a military post had been maintained for some time previous, in May, 1868, building thence on westward to Ogden, where its rails were connected with the Central Pacific, which built west from Sacramento, in May, 1869. Previous to the construction of the Union Pacific road, the overland stage route had crossed this area and for a brief space of time an alternative or southern route had been followed up the South Platte River to the junction of the Poudre, thence up the Poudre to a point immediately outside of the mountains called La Porte, and thence in a northwesterly direction to the Laramie Plains. This was probably the latest of the various stage routes to be established. The first railroad facilities given to the Poudre Valley area came with the construction of the Denver-Pacific, which built from Cheyenne, where it made connection with the Union Pacific road, southward to Denver, a distance of approximately 100 miles. This road reached the City of Denver in the year 1870. It crossed the Poudre Valley at Greeley and for many years was the only railroad in northern Colorado. In 1877, however, a road was built from Cheyenne southward, crossing the Poudre Valley at Fort Collins and connecting at Longmont with a road which had been built out from Denver. This was known as the Colorado Central and is now known as the Colorado & Southern. About 1883 a road was built traversing the Poudre Valley from Greeley to Fort Collins, and at that time, both of the systems having fallen into the hands of the Union Pacific, the railroad described as the Colorado Central was abandoned from Fort Collins to Cheyenne and the rails removed. Later, however, the old system known as the Colorado Central having passed into the hands of the Colorado & Southern Railroad, this line was re-established, or, rather, a new road was constructed, from Fort Collins through Wellington in the Poudre Valley and on northward to Cheyenne, forming a connecting link in the north and south system of the Colorado & Southern Railway, giving a connection from Galveston, Texas, to Billings, Montana, where junction is made with the Great Northern and the Northern Pacific transcontinental routes.

It thus becomes apparent that the Laramie Plains area, with its early transcontinental railroad facilities, had no disadvantage in the matter of transportation in the early history of its development, and these facilities, were, if anything, earlier, and as good as, if not better than, the facilities afforded to the Poudre Valley.

Today, however, we find that in the Laramie Plains there is not a single feeder line, with the one exception of a road

known as the Laramie, Hahn's Peak & Pacific, which built westward from Laramie across the Medicine Bow Mountains and thence southward into North Park in Colorado, whereas the Poudre Valley is today almost a network of feeder railroads. One road, commonly known as the Sugar Road, is owned and operated entirely by The Great Western Sugar Company, built for the express purpose of transporting beets from the farms to the sugar factories. This road originates at Loveland, some 14 miles south of Fort Collins. From thence it runs eastward, dividing, one branch proceeding to the southward, the other branch running northward across the Poudre Valley at the town of Windsor, at which point it crosses the branch of the Colorado & Southern between Greeley and Fort Collins, thence running eastward to a junction with the Union Pacific at Eaton. It is so constructed as to serve as a feeder for both the Union Pacific and the Colorado & Southern, as well as to serve sugar factories at Eaton and at Windsor in the Poudre Valley and at Loveland and Longmont to the south of the Poudre Valley. Furthermore, a branch of the Union Pacific runs in a southeasterly direction from Fort Collins, traversing a very rich section of the Poudre Valley and thence in a southerly direction to the City of Denver. Another road, known as the Denver, Laramie & Northwestern, in a general way, parallels the Union Pacific between Denver and Greeley. Numerous spurs of the Colorado & Southern radiate from Fort Collins, one to the westward up the Poudre River, and one to the eastward to a farming district commonly known as the Black Hollow. Two spurs have been built by the Union Pacific into the Greeley-Poudre District. These leave the main line near Greeley, the longer spur being something like 25 miles in length. These two spurs were constructed in anticipation of the development of the lands within the Greeley-Poudre Irrigation District from reclamation by irrigation.

It is therefore apparent that the Poudre Valley is furnished with remarkable facilities for transportation, whereas, in this regard, with the exception of the one road mentioned, the Laramie Plains remains today with the one transcontinental road passing directly through it which it had in the year 1868.

We are not able to enter into a discussion of any theory as to whether or not railroads are the cause or the effect of industrial development, but it is obvious that the various branches or feeders constructed in the Poudre Valley are the result of a demand for railroad facilities, with the exception of the two spurs from the Union Pacific into the Greeley-Poudre District, which are in anticipation of the development which is expected in that area, consistent with the development in the portion of the valley already reclaimed. These railroads can

be nothing less than the effect of a wonderful agricultural production.

The earliest irrigating ditch on the Laramie Plains seems to have been commenced in 1868, the second one in 1875, the third and fourth in 1877, and the fifth in 1878. These, as is natural, were all very small ditches. Then in 1879 the Pioneer Canal was constructed, at first a comparatively small ditch, but later enlarged to a ditch of considerable size with a length of something like 40 miles. In the Poudre Valley the oldest ditches are somewhat earlier, the first one dating in 1860, followed by a number of small ditches, until the establishment of the Greeley Colony, commonly known as the Union Colony, when two ditches of considerable size were built, one on the south of the river known as Union Colony Canal No. 3 was built in 1870, and was about 15 miles in length, and a larger one known as Union Colony Canal No. 2 was built on the north side of the river in 1871 and was originally about 35 miles in length.

We will not attempt to give the complete history of the construction of the various canals in the Poudre Valley, but two, heretofore referred to, are of particular interest in any comparison with the Laramie Plains. These are: the canal of the Larimer & Weld Irrigation Company, commonly known as the Eaton Ditch, which was commenced in the year 1879, the same date as the Pioneer Canal in Wyoming. This ditch heads on the north side of the Poudre River a few miles above the City of Fort Collins and traverses the Poudre Valley, crossing the Union Pacific Railroad near the City of Eaton and extending, by laterals, to the boundaries of the Greeley-Poudre District. The other one, the canal of The Water Supply & Storage Company, known as the Larimer County Canal, was commenced in the year 1881, heads upon the north side of the Poudre River some 12 miles above the City of Fort Collins and also traverses the length of the Poudre Valley, its extensions running slightly into the area of the Greeley-Poudre Irrigation District. These two canals are of particular interest because of the comparative date of their construction with the Pioneer Canal in Wyoming, and further, because, as we have explained, they are of about an average in age and show the remarkable development in irrigation and agriculture under irrigation in the Poudre Valley.

We have felt that where it was practical photographs showing the development or lack of development of these areas would be, to a reasonable degree, suitable evidence. Accordingly, we have introduced in evidence two large albums containing photographs showing the agricultural development under these two canals.

Exhibit 119 is a series of photographs taken along the general course of the Larimer County Canal. The first photograph

was taken at a point about two and one-half miles north of Fort Collins, from which point photographs were taken in an effort to show each quarter section subdivision along a highway running through the territory irrigated by this canal.

The other, Exhibit 120, is a similar set of photographs taken under the Eaton Ditch, commencing at the sugar factory immediately adjoining the City of Fort Collins and running in the same way.

Photographs were taken upon each quarter section along a highway traversing the area irrigated by this canal. This line passes through the City of Eaton some 18 miles to the east and on into the newly developed area adjoining the Greeley-Poudre District immediately to the east of Eaton. In each of these exhibits a key map will be found. For this purpose the map prepared by the United States Geological Survey was used and the location of each photograph in the album is indicated by number. The photographs correspond in number and each has a legend showing the date upon which the photograph was taken, the location and a very brief description of the scene.

We most earnestly request the consideration of the court to these photographs as being the best visual evidence which we could produce to show the conditions of development in these areas. No attempt whatever has been made to show the good and eliminate the bad. The pictures have been taken indiscriminately along the courses mentioned.

We endeavored to treat the Laramie Plains in the same way, but conditions are so radically different that we found it impossible to do this, so, instead, we had the engineers in charge of the plane table survey take a photograph of every set of farm or ranch improvements on the Laramie Plains within the area covered by the plane table survey. The only exceptions are the few instances in which, for some reason, the photograph was a failure. These are contained in an album introduced as Exhibit 116 which has a key map and number similar to that described for exhibits 119 and 120. We have but one apology to offer and that is that it was within our means to have the pictures shown in Exhibits 119 and 120 taken by a professional photographer, whereas we found this to be beyond our means in dealing with the Wyoming situation, and the photographs were taken by two of the engineers in the plane table party, so while they are not as large nor as good from an artistic sense as the Colorado pictures, nevertheless they give a fair representation, so far as pictures can show it, of the lack of development in the Laramie Plains area.

To supplement these smaller views, we had a number of large panoramic photographs taken, Exhibit 122. If there be any criticism as to the difference in photographic skill displayed in the former pictures, it is absent here, for the reason that these

panoramas were taken by the same photographer and upon successive days. In this album, the first picture is a scene taken on the Wheatland tract. The panorama covers a complete circle, and a better understanding can be had if the picture is bent into a circle with the observer in the center. A description is given immediately preceding the picture, so that it will not be necessary to describe these scenes in this brief.

The second picture is also taken in the Wheatland district.

The third and fourth were taken on the Laramie Plains and show with true accuracy the typical conditions prevailing there.

The fifth is taken on the Little Laramie River and shows how this area is devoted largely to the culture of native hay.

The sixth is a picture taken near Ault, some twelve miles north of Greeley. The area shown has but recently been brought under irrigation. It practically adjoins the Greeley-Poudre district lands. It clearly shows what development can be expected in the Poudre Valley under irrigation, even in a short length of time.

Numbers seven and eight are pictures taken at or adjoining the town of Ault.

Number nine is a picture taken near the town of Pierce, which lies within the boundaries of the Greeley-Poudre District, the cultivated lands shown are, however, irrigated by a recent extension of the Larimer County Canal, known as the Pierce Lateral, and had been irrigated for only about four years.

Number ten is a picture taken from the top of the sugar factory at Eaton and shows the surrounding farming country irrigated largely by the Eaton Canal, of which the original date of construction was the same as the Pioneer Canal in Wyoming.

Notice the contrast between this area and the Laramie Plains along the Pioneer Canal, shown in pictures three and four.

Number eleven is a scene taken nine miles east of the City of Fort Collins.

Numbers twelve, thirteen and fourteen are scenes at or near the village of Lucerne, about midway between Greeley and Eaton.

These panoramic photographs were taken August 5th to 8th, 1913, and a description of the various scenes will be found at transcript pages 3047 to 3070, inclusive. An attempt was made to get typical pictures of the various areas affected by this cause.

To show further the contrast in development, we went to the census reports and had analysis made of the various census reports for the decades 1870 to 1910, inclusive. This analysis was made by E. B. House, Professor of Civil and Irrigation Engineering at the State Agricultural College of Colorado.

He also testified to things other than that contained in these census reports, but from the census reports he made a series of diagrams comparing generally the counties of Larimer and Weld in Colorado with Albany and Laramie in Wyoming. These census reports are of relative value only. The County of Weld has been divided since the earlier reports were published and re-divisions have been made several times. In 1909 Larimer County, Colorado, was divided and that portion known as North Park, a country somewhat similar to the Laramie Plains area, was taken off. This is not shown by the census reports, except upon analysis of the area of the county. Moreover, the County of Laramie, Wyoming, has been divided and two new counties Goshen and Platte, created out of the northern half. The Wheatland District, which is involved in this controversy, is located in the new County of Platte. This division was made after the data was compiled for the census report, consequently everything contained in Professor House's analysis referring to Laramie County, Wyoming, is inclusive of the present area of Laramie County, Platte County and Goshen County. We do not know whether there has been any similar division of Albany County, Wyoming, or not, but we wish to make this point clear, that in the comparison made by Professor House we are including the area of the present counties of Platte and Goshen as part of Laramie County, Wyoming. This fact makes the comparison more favorable to Wyoming than would be true if the limits of the present counties alone be considered. The comparison, of course, should be made between the two Colorado counties and Albany County, which includes the Laramie Plains, and Platte County, which includes the Wheatland area in Wyoming, but inasmuch as the census report did not have Platte County, it had to be included within the area of the greater boundary, that is, the undivided Laramie County.

Exhibit 86 is a blue print drawn to scale showing the areas of the four counties.

Exhibit 87 is a diagram drawn to scale, showing the development according to population, comparing the combined Colorado counties with the combined Wyoming counties. In 1870 the total population of the Colorado counties was 2,474 as against 4,978 in the two Wyoming counties. The increase in population for the various decades is shown, and in 1910 it appears that the Wyoming counties (undivided) had a total of 37,701, whereas the Colorado counties, after the deductions had been made by the divisions of Weld County, was 64,447, or, if the original Weld County is considered, then the total would have been 88,499. This chart clearly shows the great increase in Weld and Larimer Counties as compared to that of Albany and Laramie Counties in Wyoming.

Exhibit 88 is a like comparison of population, except that Weld County alone is compared with Albany County, Wyoming, and it is remarkable that in the decade from 1900 to 1910, Weld County increased from 16,808 to 39,177, while Albany County, Wyoming, decreased from 13,084 in 1900 to 11,574 in 1910.

Exhibit 89 is a chart showing the comparison in rural population. In 1870 the two Colorado counties had 1,994 persons in their rural population, whereas the Wyoming counties had 2,700; in 1910 the Wyoming counties (undivided) had 18,144, while the Colorado counties (Weld County divided) had 43,649.

Exhibit 90 is a chart showing the development in the number of acres in improved farm lands. Each one of the four counties is shown separately. In 1870 Weld County had 9,715 acres of improved farm land; Larimer County, Colorado, 5,135 acres; Albany County, Wyoming, 184 acres; Laramie County, Wyoming, 125 acres. In 1910 Weld County (divided) had 410,346 acres; Larimer County, 252,262 acres, or, with North Park separated in 1909, 177,525 acres. On the other hand, Albany County, Wyoming, had decreased from 144,075 acres in 1900 to 107,315 in 1910, but Laramie County, probably due largely to the development at Wheatland, Wyoming, had increased from 93,304 in 1900 to 210,992 in 1910.

Exhibit 91 is a chart showing development in the number of farms, each county being shown separately.

Exhibit 92 shows value of improved farms.

Exhibit 93, the number of acres irrigated.

Exhibit 94, the value of farm crops.

Exhibit 95, bushels of wheat produced.

Exhibit 96, average yield of wheat per acre.

Exhibit 97, oats produced.

Exhibit 98, average yield of oats per acre.

Exhibit 99, barley produced.

Exhibit 100, average yield of barley per acre.

Exhibit 101, potatoes produced.

Exhibit 102, average yield of potatoes per acre.

Exhibits 95 to 102, inclusive, deal with ordinary farm crops. We find from them that in 1910 Albany County, Wyoming, produced only 4,068 bushels of wheat; Laramie County, 107,800 bushels; Larimer County, Colorado, 580,250 bushels, and Weld County, Colorado, 1,628,022 bushels, and even then a decrease in the wheat production in the Colorado counties is apparent with the advent of the sugar beet industry.

Likewise we find that in 1910 Albany County, Wyoming, produced 120,449 bushels of oats, Laramie County, Wyoming, 632,949; Larimer County, Colorado, 514,553, and Weld County, 856,544.

The 1910 barley production seems to be as follows: Albany County, Wyoming, 10,361; Laramie County, Wyoming, 21,946; Larimer County, Colorado, 179,847; Weld County, Colorado, 577,637.

Potatoes in 1910: Weld County, Colorado, 5,867,691 bushels; Larimer County, Colorado, 198,506 bushels; Laramie County, Wyoming, 203,016; Albany County, Wyoming, 43,729.

As we stated, these figures are relative only. Doubtless there are at times inaccuracies in statistics obtained for the Census Bureau, and we do not insist that they represent exactly the correct data in any one county, but the system was undoubtedly uniform, and the errors, if any exist, should be compensating.

Moreover, it must be borne in mind that these figures are for the four counties, taking each county as a whole, and, of course, in this case, we are comparing not counties but only portions of counties. Nevertheless, they clearly show the relative value of the areas here in controversy as agricultural districts.

Exhibit 103 in like manner shows the hay production, in 1910 Albany County, Wyoming, producing 52,748; Laramie County, Wyoming, 116,700; Larimer County, Colorado, with North Park, a hay district, taken off, 109,792, and Weld County (divided) 168,214 tons. This classification of hay includes not only native grasses but alfalfa.

Exhibit 104 shows live-stock, and here the contention of the defense that the Laramie Plains, which is in Albany County, Wyoming, is essentially a live-stock area, becomes apparent. In 1910 the total number of live-stock in Larimer County, Colorado, was 49,753; Weld County, Colorado, 84,850; Albany County, Wyoming, 199,103, and Laramie County, Wyoming, 552,153. Laramie County, Wyoming, is a heavy producer of sheep. We understand that these figures do not include sheep and cattle held temporarily for fattening. The Poudre Valley imports several hundred thousand head of sheep and cattle each year. These are fed for the market, usually during the winter months.

These exhibits, 86 to 104, inclusive, are prepared from data contained in the United States Census Reports.

An analysis was also made by Professor House of the Government meteorological reports for the stations at Laramie, Wyoming, and Greeley, Colorado. The station at Laramie is connected with the Experiment Station at that point.

Exhibit 105 is two plots showing the minimum monthly temperatures throughout each year for the decade 1893-1902, inclusive, and the decade 1903-1912, inclusive. Minimum monthly temperatures are selected instead of maximum temperatures in order to show the relative length of the season above

frost at each station. The solid irregular lines on the plots indicate the minimum monthly temperatures at Greeley; the dotted line at Laramie. The chart is graded to show temperatures from 30 degrees below zero to 60 degrees above zero, Farenheit. At a point on the plots representing 32 degrees above zero, a heavy line runs transversely across the sheet and the temperature lines above this heavy line therefore indicate the portions of the year during which no temperature as low as 32 degrees, or freezing, occurs.

The number of days in the season above frost at the two stations for each year from 1892 to 1912, inclusive, is shown on the plots and also in the abstract (2424-2428). The average for the twenty year period is 126.5 days at Greeley and 57.6 days at Laramie.

The records from which this data was taken are beyond dispute. The same methods of taking and recording temperature were pursued at the two stations, and it is conclusive testimony to the fact that for a period of twenty years the average season between frosts at Greeley was approximately two and one-half times as long as at Laramie. It must be borne in mind that the temperature lines plotted on Exhibit 105 show only the minimum monthly temperature. The exhibit in no wise is intended to indicate daily temperatures.

As an illustration of one of the extremes, it is to be noticed that in the year 1904 there were 128 days at Greeley when the temperature was above freezing, whereas it frosted every month in the year 1904 at Laramie City, Wyoming.

Within the scope of this brief it is impossible to review in detail all of the evidence showing the development and the present status of the Poudre Valley. Much evidence was introduced for this purpose, but so diversified are the interests of this valley that it was impossible to show the conditions prevailing there without the production of a number of witnesses. Suffice it to say that we have traced the history of the valley from its pioneer days when the earliest crops consisted of the production of a small amount of native hay along the river bottoms, with a very small amount of garden truck, through the expansion of the irrigated area, and the production of small grains, to the present day development, the evidence showing that probably the Poudre Valley is as advanced a region for diversified farming as can be found in the whole country. We have shown that the production of grains has relatively decreased with the introduction of other crops, notably potatoes and sugar beets, and that development has progressed until a more thoroughly modernized farming area would be hard to find. In the valley there are two small cities, modern in every respect, Fort Collins at the upper end and Greeley at the lower end of the valley, each of these having a population, according

to the 1910 census, in excess of 8,000 people; each with a large educational institution, the State Agricultural College and the Colorado Experiment Station being at Fort Collins, and the Colorado Teachers' College, commonly known as the Normal School, at Greeley. In addition to these, there are numerous other towns varying in size, the largest of which is the town of Eaton, some eight miles north of Greeley, and Windsor, midway between Fort Collins and Greeley; also towns such as Ault, Pierce, Wellington, Severance, Timnath, LaPorte, and many others which we need not give in detail; that even in the Greeley-Poudre district several small towns, more particularly Hungerford, Camfield and Briggsdale, were built in anticipation of the development of that tract.

We have shown the substantial nature of the improvements and the presence of modern conveniences, such as telephone and electricity for power and light, not only in the towns and cities, but also throughout the rural communities.

We have shown that to the west of Fort Collins, in the area which is known as the LaPorte district, intensified farming has become the rule, and that the area is devoted to a large extent to the production of fruit, such as berries, cherries and apples, and the production of garden truck, and that in this district the farms are frequently 10 and 20 acre tracts, producing, in some instances, several hundred dollars per acre per annum; that probably this sort of production was encouraged in the LaPorte district rather than other portions of the valley for the reason that this was the point at which one of the overland stage routes beforementioned left the Poudre Valley for the Laramie Plains and the settlers at LaPorte, at an early date, found a ready market for garden produce in Wyoming, particularly in the Laramie Plains area, and that this market is still availed of and great quantities of fruit and vegetables are hauled by wagons into the Laramie Plains area, as well as shipped by rail.

We have shown that there are numerous flouring mills throughout the valley, particularly at Fort Collins, where there are two, Windsor, Greeley and at Eaton, with elevators at other locations, and that the product of these mills is, to a very large extent, exported to various portions of the United States. It is significant, however, that one miller, Mr. B. F. Hottel, who testified for the defense, stated that he always had had a large market for his flour at Laramie, Wyoming (3300).

We have shown that at Greeley there is a large canning plant, at which vegetables grown in the surrounding country are canned; that cabbage, onions, celery and other garden products are raised extensively for exportation surrounding Greeley.

To the northward of Greeley, in the territory surrounding Eaton and Ault, vast crops of potatoes have been and are grown. These are known as the "Greeley potatoes," and their

fame has extended throughout the whole United States, exports being made even to Cuba, the average amount exported being 4,500,000 bushels per annum (3095-3109, 3198-3212).

We have also shown that with the year 1901 there began the development of the sugar beet industry, with the result that there are beet sugar factories located at four different places in the Poudre Valley; Fort Collins, Windsor, Greeley and Eaton; that these factories are of enormous size, modern in every way, but it would hardly be fair to permit the inference to go that these four factories in the Poudre Valley constitute all in northern Colorado. Within a radius of probably fifty miles from Greeley there are in all nine sugar factories, all belonging to one company, the Great Western Sugar Company. This is the largest sugar producing area in the State of Colorado, and it is a matter of public knowledge that Colorado leads all other states in the production of beet sugar.

With the advent of the sugar beet, modernized methods of cultivation became necessary, and throughout the Poudre Valley where diversified farming is practiced, we learn that a scientific system of rotation of crops has been adopted with alfalfa as the basic crop. Briefly stated, the system is this: ground devoted to the production of alfalfa, which is a perennial growth, yielding in the Poudre Valley about three crops a year, with an average production per annum of about four tons to the acre, is, in the course of time, plowed up and devoted to the production of beets or potatoes for possibly two years and then to the production of grain for possibly two or three years. Possibly the last crop of grain is sowed with alfalfa seed and the farmer, after cutting his grain, finds his land in a new crop of alfalfa which will yield substantially the following season. After the land has been devoted to alfalfa for a few years, the rotation is again made. In this way the nitrogen-bearing alfalfa fertilizes the soil for the other crops.

The production of sugar beets is so great as to be astounding. See Exhibit 146, page 3580. The factory at Fort Collins is capable of working up into sugar 2,200 tons of beets per day. The cultivation of beets requires a relatively large amount of hand labor, and, for this purpose, there have been brought into the Poudre Valley many persons. The matter is of interest in this, that the crop is one which furnishes a means of livelihood for more persons than practically any other ordinary farm crop. The farmer, after removing the beets from the ground, cuts off the tops and delivers the beets to the nearest railway station, where they are loaded over a contrivance known as a dump, receiving for them a price determined by the sugar content of the beets, the average price for beets, however, being about $6.00 per ton (2346) and the average yield approximating 13 tons per acre (2349). The tops which he has removed are used for feeding either cattle or sheep, and instances of

the sale of beet tops are shown in the record where as high as $3, $4 and even $7 per acre was procured by the farmer. After the sugar has been extracted from the beets at the factory, there remains a by-product ordinarily called pulp, which is run out from the factory into immense silos and from there it is sold for the feeding of cattle and a large number of cattle are finished for market in the Poudre Valley on beet pulp, with other feeds, largely alfalfa. Another by-product in the manufacture of beet sugar is a thick molasses from which a small amount of saccharine matter cannot profitably be extracted. This also is used for the finishing of cattle for market.

Moreover, the production of enormous quantities of alfalfa led, years ago, to the development of another industry which has become of vast importance to the valley, that is, the feeding of lambs for the market, and it is a matter of common knowledge that the "Fort Collins lamb," so called, is famous in the large packing centers of the United States. These lambs are not grown in the Poudre Valley. As a matter of fact, few of them come from Colorado, but southern Wyoming and northern New Mexico are the principal sources of supply. The spring lambs are purchased, for illustration, in southern Wyoming by Poudre Valley farmers in the fall, shipped into the valley, fed on alfalfa and corn for usually a period of from three to five or six months, and then shipped to the packing centers, such as Omaha, Kansas City or Chicago. The corn fed to these lambs is imported, for the reason that corn is not a successful crop in this area.

We have already mentioned that cattle are fed, but to leave the impression that the beet pulp alone was used for this purpose would be erroneous. Cattle, like the sheep, are not raised in the Poudre Valley, but are imported from live stock producing centers, and with the modification of the feed, the methods are largely the same as those followed for sheep. In this way the Poudre Valley farmer found an advantageous market for his alfalfa and also for those things which may be termed by-products from sugar beets, that is, beet tops, beet pulp and the refuse molasses. The average market price of alfalfa is usually about $6 per ton in the stack. It would be far less, however, if the feeding industry had not developed the market.

Counsel for the complainant seem to complain at the length to which we have gone in showing the development of the Poudre Valley, but we have a pardonable pride in this development and we believe that we are justified in showing these conditions, because the fact is apparent that the Poudre Valley, acre for acre, will furnish a means of livelihood for many times the number of people that can be supported by the Laramie Plains area, even under the best methods which can be brought into practice there.

The complainant contends that they can raise practically anything in the Laramie Plains. We deny this, and it is conclusively shown that from an agricultural standpoint, as the term is ordinarily used, the country is limited to the production of hay and possibly a very slight production of the hardier grains. Where we get three crops of alfalfa per year in the Poudre Valley, the Laramie Plains gets two, and its vast area now devoted to the production of native hay, which we think is the only practical crop to be relied upon, produces an average of one half of one ton per acre, and, according to the Wyoming testimony, is worth $8 per ton in the stack. In other words, we find that the only sure crop which the Laramie Plains so far has produced is native hay, yielding an income at the rate of $4 per acre. If the Laramie Plains can produce wheat, why has it not done so? They have had a flouring mill at Laramie for many years. During a larger portion of the time, according to Wyoming testimony, it has been idle. When it does run, it has run largely upon imported wheat. One witness for the complainant testifies that during 27 years, a large portion of the grain consumed in the Wyoming area has been imported (4063). Experiments in feeding live-stock, carried on at the Wyoming Experiment Station at Laramie, required the importation of alfalfa because it could not be obtained locally (4028). They have not produced sufficient garden truck to supply the local needs, and as a matter of fact, the evidence of witness after witness produced by the State of Wyoming showed that the only garden truck the ranchmen attempted was to supply their own individual needs. They contend that they can raise oats. Why have they not done so? The fact remains that the production is lacking.

Certain persons interested in the subject, induced the representatives of the Great Western Sugar Company to send representatives to investigate the possibilities of raising sugar beets. Representatives of this company, as shown by the evidence, visited the Laramie Plains and discouraged the idea that sugar beets could be produced there. However, after looking over the situation and upon the urgent demands of various persons, a quantity of sugar beet seed was sent to persons living near the junction of the Big and Little Laramies, with directions for the cultivation of the crop upon the agreement that the beets when grown would be received at one of the factories in the Poudre Valley at a fixed price per ton. Nothing was ever heard from the venture (see testimony of Hiram Timothy, 2354-2355, and Silas H. Turner, 3133).

We have heretofore discussed, under the subject of the amount of land irrigated, three exhibits, to which we wish to refer again. The first of these is Complainant's Exhibit E, the same being a tabulation of Mr. Meeker's reconnaissance of the

lands under irrigation on the Little Laramie, the total amount of which we have criticised because of the inclusion of the Centennial Valley lands. However, for the purpose of a discussion of the areas devoted to various crops, it may be considered as it stands. In this table, Mr. Meeker classifies the lands into meadow, pasturage, oats and alfalfa. Considerable evidence had been introduced by various witnesses as to the oats which had been produced in the Little Laramie region, particularly upon what is probably the best ranch in that region, known as the Blackburn ranch, the area of which is included in the total given on this Exhibit E.

In this table, Mr. Meeker has a grand total of 49,553 acres, and of this, he classifies 26,842 acres as being meadow land, 20,077 acres as pasture, 2,314 acres as oats, and 300 acres as alfalfa land. This meadow land is native hay; the pasture land is probably land which is irrigated but which does not produce a sufficient amount of grass to justify cutting as hay and is therefore used as a pasture. Our brother Corthell for the complainant in the examination of witnesses, frequently refers to it as irrigated pasturage.

It therefore appears that out of this total amount of acreage, Mr. Meeker was able to find as devoted to agricultural crops in the accepted sense of the word, only 2,314 acres upon which oats were grown, and 300 acres devoted to alfalfa.

Keeping in mind the difference in the number of acres shown by Mr. Meeker's reconnaissance and the survey made by the defendants of this area, let us consider Exhibit 117, which is a similar tabulation, somewhat more in detail, based upon that survey of the Little Laramie area. This survey disclosed, as we have heretofore shown, 31,341 acres in this area, of which 22,081 acres was meadow land, producing native hay; 5,801 irrigated pasturage, 219 acres alfalfa, 1,319 acres oats, 933 acres plowed ground, upon which no crops were grown in the year 1913, but which had been plowed either that year or some preceding year. In addition, the survey disclosed 88 acres devoted to various other crops, including a total of 10 acres of potatoes, 43 acres of wheat or other grain except oats, 19 acres of flax, 14 acres of barley and 2 acres of turnips.

A similar tabulation to Exhibit 117 was made of the lands on the Big Laramie River, covered by the survey, Exhibit 118, except that in Exhibit 118 the lands are given under the respective ditches, whereas the individual ditches are not considered in Exhibit 117.

Exhibit 118 discloses a total of 29,279.3 acres of which 24,588.7 is meadow land, classified as first, second and third class meadow, but inasmuch as after the plane table survey had progressed, we adopted the Wyoming nomenclature for what we were theretofore terming third class meadow and call-

it irrigated pasture, which in fact it is, this total of meadow lands should really be 17,651.9 acres of meadow lands and 6,936.8 acres irrigated pasture. The survey showed a total of 1,440 acres of alfalfa, 831.6 acres of oats, 211.9 acres of other grain, 27.4 acres of potatoes, 17.6 acres devoted to gardens and 2,162.1 acres plowed ground upon which no crops were grown in the year 1913. It will be recalled that Exhibits 117 and 118 are based upon absolute survey of these lands. The two combined may be tabulated as follows:

Meadow	39,732.9
Pasture	12,737.8
Alfalfa	1,659.0
Oats	2,150.6
Other grain	268.9
Potatoes	37.4
Garden	19.6
Flax	19.0
Plowed ground	3,095.1

Attempts were made to secure, by actual measurement, the production of native hay and alfalfa per acre. The witnesses for the complainant had frequently referred to alfalfa on what is known as the Hart ranch. Accordingly, the engineers in charge of the plane table survey made measurements for the purpose of ascertaining the number of tons per acre which this farm produced. In the year 1913, the first cutting of alfalfa on the Laramie Plains commenced July 7th (2631) and the second cutting about September 18th (2752). In the Poudre Valley the first cutting usually commences in the fore part of June, the second cutting about the middle of July, and the third in September, the second cutting coming at approximately the same date in July as the first cutting on the Laramie Plains. The first cutting on the Hart Ranch, a short distance above Laramie City, produced 320 tons from 481 acres; the second cutting 252½ tons, or a total for the two cuttings of 572½ tons, an average of 1.2 tons per acre (2633). The witnesses were, of course, not able to state that alfalfa might not have been hauled from the field and not stacked, and so admitted. The amount was determined by measuring the stacks, but if any hay was hauled away, the fact was not shown by the complainant on rebuttal. This tract of alfalfa land on the Hart ranch is supposed to be the best, or one of the best, on the Laramie Plains.

Other measurements were made of the first cutting alone at other places. For illustration, the first cutting on the Hoge ranch yielded 1.1 tons per acre (2634), and the first cutting on the Buntin ranch yielded approximately one ton per acre (2635).

The native hay grown upon the Bath ranch on the Little Laramie River was likewise measured. There is, of course, only one crop of native hay per year. The Bath ranch was described by witnesses for the complainant as being one of the best meadows on the Laramie Plains. The yield from 423 acres was, by actual measurement, 253.2 tons, or approximately six-tenths of a ton per acre (2635). (We note that in the abstract the decimal point has been omitted, so that it erroneously reads 6 tons per acre.)

Similarly, efforts were made to ascertain the yield of grain per acre. Oats on the Blackburn ranch on the Little Laramie River (the show ranch of the Laramie Plains) yielded 24 bushels per acre; wheat, 11 bushels, and 19 acres of flax, 8 bushels per acre. Crops on this ranch are above the average in the Laramie Plains area. Another field of 63 acres of oats on this same ranch yielded 12.6 bushels per acre (2757).

The defendants felt that the testimony of some impartial expert on the merits as agricultural districts of the Laramie Plains and the Poudre Valley was advisable. Accordingly we procured the services of Dr. L. H. Bailey of Ithaca, New York, one of the highest authorities on agriculture in the United States. Dr. Bailey was, for many years, director of the agricultural experiment station at Cornell, and is probably best known as chairman of the Country Life Commission, appointed by President Roosevelt in 1909. His testimony is found in the abstract at transcript pages 2575 to 2615, inclusive. He testifies that he had once made a very brief visit to Laramie, Wyoming, but had never been in the Poudre Valley in Colorado prior to the year 1913; that on September 16th, 17th, 18th and 19th, he made a trip of inspection over the Poudre Valley, including the Greeley-Poudre Irrigation District, and over the Laramie Plains. This trip was made in an automobile under these conditions, that he should reach his own conclusions, free from any suggestion or argument from any person representing the defendants, directly or indirectly, but every facility was given in order to enable the witness to see everything necessary.

At Laramie, Dr. Bailey met some of the persons connected with the Agricultural College and Experiment Station, and on his reconnaissance saw what was said to be the best, from an agricultural standpoint, on the Laramie Plains.

After this trip of inspection, Dr. Bailey testifies that he made an investigation of various reports, such as census reports, soil surveys, meteorological reports, bulletins and other printed matter. Some three months after his visit, he made a report to the State of Colorado which resulted in his being called as a witness by the defendants.

He says that the two areas are not to be compared, but contrasted (2584); that he was greatly impressed with the

development of the Poudre Valley; in the industry he saw everywhere, the great number of people, the teams met on the roads hauling produce, the well-developed road systems, the character and number of the dwellings, from four to seven and sometimes more per section, established homes with good yards, small orchards, vegetable gardens; the shade trees along the highways; the frequent school houses and the thriving towns and villages; the excellent character of the soil and the crops such as alfalfa, sugar beets, potatoes, garden stuff, with storage cellars and sugar factories. "Altogether it seemed that in that region there was a highly developed rural section, founded directly on agriculture."

He then went directly into the Laramie Plains "and found a very different state of conditions." The country was more open, with a relatively small number of houses and few teams on the roads, which were excellent but with not so many of them laid out along the rectangular section lines. There were fewer shade trees, with the natural vegetation less vigorous; no rural towns outside of Laramie founded on agriculture. Saw some very attractive places, although these were not so numerous as in the Poudre Valley. Impressed with the gravel in the soil, saw some good crops of certain things, but not nearly so many as in the Poudre Valley and growing only in places here and there; very little garden truck and no fruit trees, with one exception, those at the Lund place at the head of the valley. The witness says that he saw a good number of special crops on trial, largely at the Experiment Station, which he did not enter because the frost had killed a good part of the experimental work for the year.

The witness testifies further that he had a definite impression that so far as new crops were concerned, practically everything was on trial on the Laramie Plains and that high development would be limited to special places where there is some peculiarity in soil and particularly where there is protection from climate. He says:

> "The Laramie Plains struck me as being primarily a region of live stock adaptability and in general the Greeley District is already a highly developed cropping region.
>
> It struck me that the Greeley District, acre for acre, is capable of maintaining a more intensive and more diversified cropping business, yielding as a whole more crop products and sustaining a denser population from agricultural products of the land. All these conclusions appealed to me as being self-evident.
>
> I arrived at these conclusions from my general observation of the two regions. Of course, when I came

to analyze the observations, I found that they rest on two general classes of facts, so far as I have been able to analyze them.

In the first place, the fact of actual relative lack of development of the Wyoming district as compared with the Colorado district, and second, the very considerable natural differences in elevation, configuration, latitude, soils and climate."

"If one goes into a new or developing country as a stranger, he thinks he is able to judge very well of it by observing what has already taken place in older or developed parts near-by. It is approximately the only method one has to apply. Although these two regions were open to settlement at approximately the same time, there is a very marked difference in the state of development of them."

Dr. Bailey then refers to the established reputation of the Poudre Valley area for its potatoes, sugar beets, canning crops and other products, stating that it is no longer a doubtful or experimental region, that its agricultural success seems to be assured, and that the lands within the new area, that is, the Greeley-Poudre District, have apparently as good natural adaptabilities as the adjacent lands in the vicinity of Eaton.

On the other hand, he testifies the Laramie Plains to be sparsely settled, comparatively low values, relatively little land under the plow, although there are some apparently profitable ranches.

In the Poudre Valley, the farms are small, indicating relatively intensive cultivation. In the Laramie Plains they are large, indicating less production per acre.

Dr. Bailey then reviews at considerable length various official reports and bulletins showing the character of the development in the two areas which were cited "not for the purpose of giving statistics, but in confirmation of the judgment at which I had arrived independently."

The witness then states:

"The Laramie Plains had the advantage of a transcontinental railroad. Both regions have had the possibility of developing a good water supply for irrigation. As far as I am able to judge, the Colorado region under discussion has developed continuously, or nearly so, with practically all of its irrigable lands under good or even high state of cultivation. The Laramie region has developed here and there in large ranches with some smaller establishments with very much other space that is merely

fenced and used for grazing. Of course, it is evident upon the face of it that settlers have desired the Greeley region more than the Laramie region. Of course, I am stating this not in any discouragement to development of the Laramie Plains, that must be understood, but as an assertion as to how the two areas struck me, and also as indicating that the two regions are of different character. I think this fact must be recognized when Plains Region is fully developed. It seems to me that that region will undoubtedly further develop approximately as a grazing, and to some extent as a feeding, region with such accompanying forage as can be grown with profit, and for the most part, this probably will mean its development in relatively large areas. Taking that country as a whole, as I saw it, it struck me as a region of relatively low crop production, both in totals and per acre, and also a fluctuating production, not overlooking the fact, however, of exceptions in particular places."

Witness then reviews the census figures, commenting upon the difference in rural populations, stating that:

"What has been done indicates in a general way what may be expected."

He reviews the capabilities of the two areas in crop productions, showing the comprehensive nature of the adaptability of the Colorado area for crops and the limited character of the Wyoming area. He reviews the Government soil survey reports, the soil indicating that the agricultural development of the Poudre Valley, as surveyed, far surpasses that of the Laramie region. He reviews the climatic conditions, stating that the Laramie Plains is one of the most elevated agricultural regions in North America and is therefore one of the most interesting. He states that elevation can be projected into latitude and that if this be done, the Laramie Plains area might be equivalent, other things being equal, to a point in general latitude of Edmonton, Alberta, except that the Laramie Plains lacks the greater length of day which prevails in the northern latitude.

The witness then reviews the meteorological records, taking into consideration temperature and rainfall, comparing the records at Fort Collins with those at Laramie, whereas the previous witness, Professor House, compared the Greeley records with those at Laramie. He states:

"So far as meteorological records are valuable for determining the fitness of these regions for agriculture, one would have no hesitancy in saying that the region

measured by the Fort Collins records offers very decided advantages over that measured by the Laramie records."

and concludes:

"To briefly sum up the principal reasons why the Poudre Valley area is, in my judgment, so much superior to the Laramie Plains area, as an agricultural region, I think I cannot do more than practically repeat the statement I have already made in my testimony. I feel that the development that is in the general Greeley District is one that is destined to produce more value per acre and greater diversity in cropping, to maintain a bigger rural population and more rural industries founded on agriculture. The general fundamental reasons for these differences, as I have already indicated, I think chiefly are soil and climate, particularly the latter, for the reason it is difficult to overcome climate, but it is possible to overcome some difficulties in soil conditions. In other words, I should regard the climate to be a more important controlling factor than soil, other things being equal, if the soil is such that crops can grow in it at all."

PRIORITY OF DIVERSIONS.

The defendants feel that priority of right as between users in different states has no place in a suit between sovereign states affecting the water of interstate streams, except possibly, that the relative priorities might be one of many factors from which the court would determine the reasonableness of the use in one state as against another, or, in other words, might be one factor in determining the equities between the states.

We believe the decision of this court in the case of Kansas vs. Colorado, 206 U. S., 46, is decisive of this contention.

However that may be, we have felt that we cannot neglect a complete review of the evidence showing the respective priorities of diversion from the Laramie River in Colorado and Wyoming, more particularly the later diversions in both states, which are more directly affected in this cause.

An extended review of the evidence upon this question, together with a discussion of the law on the subject is set forth in Part II, Volume 2 of this brief.

We believe that it will be more convenient to divide the brief in this manner, because of the great length to which we have already gone in a discussion of the more general features of the case. However, at this point, we desire to call attention to the fact that the Greeley-Poudre diversion from the Laramie

River dates from August 25, 1902, and, under the law of the State of Colorado, the priority is established by judicial decree as of that date as against all other Colorado priorities on the River. On the other hand, the evidence discloses that all of the larger diversions in Wyoming, with the exception of the Pioneer Canal and the system of works designed for the irrigation of the original Wheatland tract, are junior in point of time to the Greeley-Poudre system. The evidence discloses that the surveys for the Lake James system were begun upon March 22, 190 (638); for the Lake Hattie system, April 16, 1908 (646, 774); for the Sodergreen High Line, November, 1907 (445); for the extension of the Wheatland system to the Bordeaux tract, in February, 1904, and to the Sybille tract in August, 1907. (108.) These dates are all shown by the evidence and are further confirmed by the permits issued by the State Engineer and the Board of Control of Wyoming, which constitute the official findings of the date of priorities, subject, of course, to review as we have heretofore mentioned.

We have shown that Lake Hattie has a capacity of 110,500 acre feet, of which 68,500 acre feet is active or available capacity; Lake James has a capacity of 41,100 acre feet. We do not recall that the capacity of the Sodergreen High Line ditch is fixed, but the extension of the Wheatland canals to the Bordeaux and Sybille tracts, so far as they are constructed, are designed for the irrigation of 10,000 and 30,000 acres, respectively. It therefore appears that permits have been issued for works which are now constructed, in whole or in part, for the storage in these two reservoirs, counting active storage only, of 109,600 acre feet per annum, and in addition to these reservoirs, the irrigation of land in excess of 40,000 acres.

This statement is not intended, however, to include many other proposed projects, nor the proposed irrigation of other lands, but is limited to the five projects mentioned, all of which are junior in point of time to the Greeley-Poudre system.

The total extent of the acreage proposed to be irrigated in Wyoming by projects junior to the Greeley-Poudre system is set forth in tabulated form in the portion of the brief referred to devoted to the question of priority of diversions.

INTER-WATERSHED DIVERSIONS.

The defendants have shown that inter-watershed diversions are in existence where necessity requires throughout the world wherever irrigation is practiced. We have shown the existence of such diversions in India, some ancient and some modern works; in Italy, in France, Spain, Turkestan, in British Co-

lumbia, Alberta, Hawaiian Islands, Ceylon, and in every state in the Union where irrigation is practiced, these last projects being not only private projects, but also in some instances projects undertaken by the United States Reclamation Service, and the remarkable thing is that while the complainant denies the right of the defendants to divert water from the Laramie River into the Poudre River, nevertheless, under permits issued by the State Engineer of the State of Wyoming, which culminated in decrees by its Board of Control, affirmed on appeal by the courts of the state, Wyoming is itself at this time, and has been for many years, actively engaged in the practice of diverting water from one watershed to another. (1445-1600, Exs. 22-50.)

A monograph upon this subject, together with an exhaustive discussion of the law, is set forth in Part I, Volume 2 of this brief.

CONCLUSIONS OF FACT.

From the foregoing, it appears that the evidence discloses:

That the total flow of the Laramie River and its tributaries in both Colorado and Wyoming is something in excess of 470,000 acre feet per annum, and of that amount, 431,200 acre feet is the normal average flow of the river available above and including the Wheatland tract.

Of this total flow, Colorado furnishes at least 250,000 acre feet per annum, the evidence varying from 220,000 acre feet according to one Wyoming witness, to 250,000, 300,000 and 320,000 acre feet according to the Colorado witnesses.

Of the 250,000 acre feet furnished by the State of Colorado, we are now diverting for irrigation 20,000 acre feet per annum, and seek to divert 56,000 acre feet in addition, with a probability that at some time this 56,000 acre feet may be enlarged to 71,000 acre feet. Assuming this contingency, Colorado seeks to divert 91/250ths of its own water, and this amount marks the limit to which Colorado can go in the diversion of water from the Laramie River. The rest of the water must for all time remain in the stream for the benefit of Wyoming if she needs it.

That irrigation methods and irrigation systems in Wyoming have been and still are primitive; that necessity has never required the officers of that state to make any definite attempt at the division of the water of the stream according to the respective rights of the appropriators; that wasteful methods have prevailed and still do prevail over a large portion of the Laramie Plains area, and that the amount of water used has been far in excess of the amount actually needed, and that

Wyoming has most excellent natural storage facilities which have been, to a certain extent, utilized at a remarkably low cost.

That the only expert testifying for the State of Wyoming says that the duty of water on the Laramie Plains area is one acre foot per acre.

That the total amount of land under irrigation from the Laramie River and its tributaries in Wyoming is 108,073 acres, including 29,074 acres in the Wheatland tracts and 78,999 acres on the Laramie Plains.

That while the Wheatland area is a relatively fair agricultural district, it has an ample water supply for many times the amount of land now under irrigation, and has, in fact, diverted more water than the law of the State of Wyoming permitted or necessity required; that the Laramie Plains is an area where climatic conditions are so adverse that its agricultural development has been and will be limited to the production of hay and a few other hardy crops, capable of resisting the severity of the climate.

That the lands of the Greeley-Poudre District are dependent for reclamation upon water from the Laramie River, which, when supplied, will bring about a development within the district equal to the development in the adjacent lands in the Poudre Valley; that the development already reached in the Poudre Valley is one wherein the highest agricultural production obtains, with a possibility of still further development in the future, supporting many times the number of people per unit of area as can be or have been supported by the Laramie Plains; that the same quantity of water, applied for irrigation upon the Poudre Valley will produce from five to ten times the amount that could be produced by the application of the same amount of water upon the Laramie Plains.

That even for the sake of argument, assuming a shortage of water in the Wyoming territory effected because of the diversion to the Greeley-Poudre District, nevertheless a far greater benefit to mankind will result from the application of that water in the Poudre Valley rather than upon the Laramie Plains.

That after the diversions have been made by Colorado, there will remain available for irrigation in the State of Wyoming in the watershed of the Laramie River, far more than sufficient for its present needs, and even a surplus amount for vast increase in the amount of land under irrigation.

That the prior diversions from the stream, under the laws of the respective states, are in Colorado, and

That the diversion by Colorado from the watershed is consistent with the highest economic use permitted the world over where irrigation is a necessity.

Therefore, the defendants contend that their diversion from the Laramie River into the Poudre by means of the Greeley-

Poudre system, will in no wise injure the State of Wyoming, and that the equities between the two states are such that this use is in no wise an unreasonable exercise of the rights of the State of Colorado as a sovereignty.

ESTOPPEL.

As a portion of their third defense, the corporate defendants allege:

> "Defendants aver that the plaintiff and its citizens, long prior to the institution of this suit and at all times, were fully advised of the said diversions and proposed diversions of these defendants and their predecessors in title, and have been advised of the formation of said district, of the voting of the bonds thereof, of the sale of said bonds to innocent purchasers for value, of the said construction for the purpose of effecting said diversion, and of the steps taken by citizens in said district in reliance thereon.
>
> Defendants aver that plaintiff and its citizens are equitably estopped from questioning the diversions sought to be enjoined herein." (Pages 17-18.)

We have already observed that, commencing with August 25, 1902, work was continually prosecuted, first in engineering, then in necessary road construction, and, lastly, in canal, reservoir and tunnel construction in the high mountain regions in Colorado surrounding the Greeley-Poudre system; that road construction began in 1903 and proceeded during the working season, and that excavation on canals commenced in 1904 and was prosecuted with great diligence thereafter; that between August 25, 1902 and March, 1908, less than six years, more than $292,000 had been expended upon the Greeley-Poudre project, in addition to moneys expended for properties necessary to the successful operation thereof; and that at the time of the trial of this cause, the Greeley-Poudre tunnel, 2½ miles in length, and rivaling in magnitude the works of the Government of the United States, had been completed through the mountain chain between the two rivers at a cost of $600,000.00, and concrete lining had been installed wherever necessary at an additional cost of over $20,000. More than $250,000 had been expended on the collection ditches in the Laramie River drainage and more than $1,825,000 in cash on construction on the general system prior to the filing of the bill of complaint herein on May 29, 1911.

In carrying on this gigantic work, supplies, machinery and labor were freighted by wagon train from Laramie and other Wyoming shipping points across the Laramie Plains and up the Laramie River Valley in both Colorado and Wyoming. From 1902 until after the filing of this suit, these activities in Colorado were well known to the officials of Wyoming and to her citizens along the Laramie River Valley in that state (2064), and no action was taken to prevent construction of the Greeley-Poudre enterprise during the years 1902-11 inclusive, during all of which time open and notorious ditch and tunnel construction was proceeding with large forces of men, teams and machinery, while Wyoming and her citizens stood idly by without protest, while Colorado and her citizens proceeded to construct the enterprise and to make the enormous expenditure above mentioned.

Notwithstanding that Wyoming and her citizens well knew of the opening of the Colorado project in the early years of 1902-3, plaintiff took no action to utilize or divert the enormous quantity of unappropriated water still remaining available in the Laramie River, until about the close of the year 1907, and March and April in 1908, at which time the new and theretofore uninitiated Lake James, Lake Hattie and Wheatland projects were first commenced. These new projects were authorized by plaintiff State when she well knew that the State of Colorado and her citizens had, almost six years prior thereto, appropriated a portion of the remaining waters of the Big Laramie River, and well knew that the Colorado appropriators were proceeding in good faith to complete their enterprise with diligence.

In view of the entire record, and particularly those facts above mentioned concerning which there is little, if any, contradiction, it would seem needless to further urge that plaintiff State and its citizens are guilty of laches and remained silent when they should have spoken and that they are now estopped to here deny the State of Colorado the right to divert and beneficially use a portion of the waters of the Laramie River so rising and flowing within her borders, and which, were it not for her Greeley-Poudre diversion, must flow out across neighboring states and into the Gulf of Mexico while her otherwise fertile lands remain forever arid and non-productive.

New York City vs. Pine, 185 U. S. 93, 98.

If it be asserted that certain letters of September, 1909, purporting to have been sent to certain interested individuals by an official of Wyoming, constitute even the semblance of protest, let it be remembered that these letters were first written and sent more than seven years after the Greeley-Poudre project in Colorado had been initiated, and during all of which

time construction had been proceeding upon the entire system both in the Laramie and Cache la Poudre valleys, and that over $800,000.00 (2159) had already been expended upon the same and identical system now in process of completion for the Greeley-Poudre Irrigation District which stands simply in the relation of a purchaser of the project definitely planned and in a large measure constructed long before the formation of the defendant district and the writing of the aforesaid letters.

Let it be further remembered that the same official who uttered this tardy communication continued thereafter to find that still unappropriated waters existed in the Laramie River and to issue new permits to still other new and junior projects in Wyoming, thereby solemnly proclaiming to all the world that unappropriated water remained after supplying all prior and other diversions from the Laramie River, and in effect finding that the statements contained in his communication were ill-advised and unfounded. It would be unreasonable to argue at that late hour that the fortunes so invested and all the many obligations assumed and undertaken on faith of the Greeley-Poudre enterprise could or would be lightly cast aside and utterly abandoned upon so tardy a murmur of protest.

The official acts, permits and decrees of plaintiff State, adjudicating in advance a water supply for irrigation of more than 278,000 acres of land to new projects first initiated and undertaken six years and more subsequent to the initiation of the Greeley-Poudre project in Colorado, estop her to now say that the small diversion to be made by the Greeley-Poudre project can in any wise injure any prior or other projects in Wyoming, for so to do is to admit that each of the new permits (1907-8 and subsequent) is, upon its face, false and untrue, and the promulgation of a fraud by and under the sanction of plaintiff State upon every investor in any newly permitted enterprise and every land owner thereunder.

Wyoming, by her own statute of limitations, is precluded and estopped to assert any claim other than that set forth in her quasi-judicial decrees and permits, by all of which she asserts that after all Colorado diversions there must still ever remain ample water in the Laramie River to justify the construction, operation and use in other new and junior Wyoming enterprises without injury to other appropriators.

The entire record furnishes ample ground to assert that Wyoming and her citizens are estopped to here deny Colorado and her citizens the right to divert a portion of the water rising and flowing within her own borders for the irrigation and reclamation of her lands, and the development and use of her own resources in the manner and to the degree permitted by the Greeley-Poudre system.

THE LAW OF THE CASE.

We have now discussed the facts of this case and to them, as summed up, we will endeavor to apply the law of the case.

When Colorado became a state in 1876, she became sovereign within the limits of her territory except as to the limited and enumerated powers given to the national government. She became the owner, in her sovereign capacity, independent of and behind her people as to all her great natural resources such as air, light and water, with equal rights as the original thirteen states.

> "One cardinal rule, underlying all the relations of the States to each other, is that of equality of right. Each State stands on the same level with all the rest. It can impose its own legislation on no one of the others, and is bound to yield its own views to none."
>
> Kansas vs. Colorado, 206 U. S., 97.

The State of Colorado and the State of Wyoming respectively have the same equal rights as any one of the thirteen original states, and as to the waters of their interstate streams, their respective rights are the same as to the waters thereof within their limits as though they were one of the original thirteen states, except as to the factors of the waters being of an interstate stream and in an arid country. The controversy is not one between private parties, as in Bean vs. Morris, 221 U. S. 485; Rickey vs. Miller & Lux, 218 U. S. 258, which cases will be hereinafter discussed, but is a case between two sovereign commonwealths insisting respectively upon the waters here in controversy, Colorado insisting upon making the diversion in her right as a sovereign commonwealth and Wyoming insisting in the same capacity on the right being denied.

Mannville Co. vs. Worcester, 138 Mass., 89, decided in 1884, opinion by Mr. Justice Holmes, then of the Supreme Court of Massachusetts and now and for many years last past a Justice of the Supreme Court of the United States, was an action of tort for diverting the waters of a natural stream in the Commonwealth of Massachusetts and preventing the same from coming to plaintiff's mill in the adjoining state of Rhode Island. The action was treated as an action between private parties. It was held that it would lie upon the ground that the servitude was being exercised with the presumed consent of the Commonwealth of Massachusetts. It is clear, however, throughout the opinion that if the Commonwealth of Massachusetts were objecting, the objection would be effective and that it was compe-

tent for Massachusetts to control the great natural resources within her limits. *Inter alia the* court said:

> "A concurrence of the laws of both States is as necessary in that case as in the one at bar, to create a liability which can be enforced in either State consistently with principle. * * *
>
> Of course, the laws of Rhode Island cannot subject Massachusetts land to a servitude, and, apart from any constitutional considerations, if there are any, which we do not mean to intimate, Massachusetts might prohibit the creation of such servitudes. So it might authorize any acts to be done within its limits, however injurious to lands or persons outside them. But it does not do either. It has no more objection to a citizen of Rhode Island owning an easement, as incident to his ownership of land in that State, than it has to his owning it in gross, or to his purchasing lands here in fee. * * * So far as their creation is concerned, the law of Massachusetts governs, whether the mode of creation be by deed or prescription, or whether the right be one which is regarded as naturally arising out of the relation between the two estates; being created, the law of Rhode Island, by permission of that of Massachusetts, lays hold of them and attaches them in such way as it sees fit to land there, Massachusetts being secured against anything contrary to its views of policy by the common traditions of the two States, and by the power over its own territory which *it holds in reserve.*"

The language contained in this opinion becomes more significant as we read the opinions of the Supreme Court of the United States as to the questions there involved, wherein that court speaks through the same jurist, Mr. Justice Holmes.

Hudson Water Co. vs. McCarter, 209 U. S., 353, opinion by Mr. Justice Holmes, decided in 1907. Here the question was between a private party and the State of New Jersey, the state being represented by its Attorney General, McCarter. The defendant, the Hudson Water Company, under a contract with the City of Bayonne, in New Jersey, had laid mains for the purpose of carrying water to Staten Island in the State of New York. By other contracts it was to get the water from the Passaic River at Little Falls, where the East Jersey Water Company has a large plant by which the water is withdrawn. The State of New Jersey, reciting the need of preserving the fresh water of the state for the health and prosperity of the citizens, enacted that it should be unlawful to transport the waters of any river of the state into any other state for use therein. Action

was brought by the State of New Jersey to enjoin carrying the waters of the Passaic River out of the state. The action was sustained. *Inter alia* the court said:

> "But we prefer to put the authority which cannot be denied to the state upon a broader ground than that which was emphasized below, since in our opinion it is independent of the more or less attenuated residuum of title that the State may be said to possess. * * *
>
> It sometimes is difficult to fix boundary stones between the private right of property and the police power when, as in the case at bar, we know of few decisions that are very much in point. But it is recognized that the State as quasi-sovereign and representative of the interests of the public has a standing in court to protect the atmosphere, the water and the forests within its territory, *irrespective of the assent or dissent of the private owners of the land most immediately concerned.* Kansas v. Colorado, 185 U. S. 125, 141, 142; Id. 206 U. S. 46, 99; Georgia v. Tennessee Copper Co., 206 U. S. 230, 238. What it may protect by suit in this court from interference in the name of property outside of the State's jurisdiction, one would think that it could protect by statute from interference in the same name within. On this principle of public interest and the police power, and not merely as the inheritor of a royal prerogative, the State may make laws for the preservation of game, which seems a stronger case. Geer vs. Connecticut, 161 U. S. 519, 534."
>
> "It appears to us that few public interests are more obvious, indisputable and independent of particular theory than the interest of the public of a State to maintain the rivers that are wholly within it substantially undiminished, except by such drafts upon them as the guardian of the public welfare may permit for the purpose of turning them to a more perfect use."
>
> "But we agree with the New Jersey courts, and think it quite beyond any rational view of riparian rights that an agreement, *of no matter what private owners*, could sanction the diversion of an important stream outside the boundaries of the State in which it flows. *The private right to appropriate* is subject not only to the rights of lower owners but to the initial limitation that it *may not substantially diminish one of the great foundations of public welfare and health.*
>
> We are of opinion, further, that the constitutional power of the State to insist that its natural advantages

shall remain unimpaired by its citizens is not dependent upon any nice estimate of the extent of present use or speculation as to future needs. The legal conception of the necessary is apt to be confined to somewhat rudimentary wants, and there are benefits from a great river that might escape a lawyer's view. But the State is not required to submit even to an aesthetic analysis. Any analysis may be inadequate. It finds itself in possession of what all admit to be a great public good, and what it has it may keep and give no one a reason for its will. * * *

It constantly is necessary to reconcile and to adjust different constitutional principles, each of which would be entitled to possession of the disputed ground but for the presence of the others, as we already have said that it is necessary to reconcile and to adjust different principles of the common law. * * * The right to receive water from a river through pipes is subject to territorial limits by nature, and those limits may be fixed by the State within which the river flows, even if they are made to coincide with the state line."

The court, in the course of the opinion, says:

"Problems of irrigation have no place here."

The opinion shows, however, the rights of a sovereign state in the streams of the state, when such right is unaffected by and is not required to be reconciled with the problem of irrigation.

Walbridge vs. Robinson, 22 Idaho 240, decided in 1912, was an appeal from an order granting a writ of mandate resulting in a reversal of the lower court. Respondent made an application to the state engineer for a permit to appropriate water from Bear Creek, a branch of Clear Water River, situate in Idaho County. This application was for the diversion of waters to be carried and applied to irrigation in the state of Montana. The permit was issued. Prior to its issuance, a similar permit had been granted for the diversion of waters from Bear Creek to be carried and used in the State of Montana. Subsequent to the issuance of these permits, a contest was filed by the respondents and after a hearing, the state engineer refused to take any action on the matter or grant any relief to either of the parties upon the ground that in issuing the permits he had exceeded his lawful authority in attempting to grant a right for the diversion of waters of that state to be applied to a beneficial use in another state. Thereafter respondents asked that they be given certificate of the completion of their works. The engineer

refused to take action on the ground that he had no authority to grant such certificate. A suit was thereupon instituted. Bear Creek was not an interstate stream, but located wholly within the State of Idaho. There was a declaration of the constitution as to the ownership of waters similar in legal effect to our own. Commenting thereon the court said:

> "It is further contended that this latter declaration of the statute is only a written expression of what the law has always been with reference to the public waters of a state.
>
> Freund, in his work on the Police Power of the state, at sec. 417, seems to entertain this view, and in discussing similar statutes in other states, says: 'Such declaration is expressive of what is believed to be the law, and does not intend to make new law.'
>
> We think it is clear that the title to the public waters of the state is vested in the state for the use and benefit of all the citizens of the state under such rules and regulations as may be prescribed from time to time by the law-making power of the state. This is not, however, an interest or title in the proprietary sense, but rather in the sovereign capacity as representative of all the people for the purpose of guaranteeing that the common rights of all shall be equally protected and that no one shall be denied his proper use and benefit of this common necessity. * * *
>
> There is no doubt in our minds but that the state in its sovereign capacity is the owner of the waters flowin the streams thereof and may exercise its authority over the same. If the foregoing propositions be correct, the state has the right to prohibit the diversion of the waters of its stream for use outside of and beyond the boundaries of the state. In other words, as said by the supreme court in Geer v. Connecticut, supra, 'The common ownership imports the right to keep the property, if the sovereign so chooses, always within its jurisdiction for every purpose.' "

The sovereign right of each one of the states of this Union of states to own and protect its great natural resources and its privilege to come into this court and ask legal protection of the right to such great natural resources appears through these cases.

In Missouri vs. Illinois, 180 U. S., 208, and 200 U. S. 496, the latter decided in 1905, opinion by Mr. Justice Holmes; Kansas vs. Colorado, 185 U. S. 125, and 206 U. S. 46, decided

in 1906; Georgia vs. Tennessee Copper Co., 206 U. S., 230, 237 U. S. 474, opinion by Mr. Justice Holmes.

It is clear that there is a sovereign right in the state independent of and behind the title of its citizens in its great natural resources, and that this court has jurisdiction of the legal contest to protect and enforce such rights. Further, that the extent to which a sovereign state may insist on this right largely rests with her. In Hudson Water Co. vs. McCarter, supra, it is said:

> "It finds itself in possession of what all admit to be a great public good, and what it has it may keep and give no one a reason for its will."

In Missouri vs. Illinois, the court recognized the right of Missouri to come by original suit into this court and protect its citizens against any contamination that might arise through sewage of the city of Chicago being turned into a tributary of the Missouri River.

In Georgia vs. Tennessee Copper Company, a bill in equity was filed in pursuance of a resolution of the legislature and by direction of the Governor of Georgia, to enjoin defendant copper company from discharging noxious gas from their works in Tennessee over the plaintiff's territory. *Inter alia*, the court said:

> "The case has been argued largely as if it were one between *two private parties;* but it is not. The very elements that would be relied upon in a suit between fellow-citizens as a ground for equitable relief are wanting here. The State owns very little of the territory alleged to be affected, and the damage to it capable of estimate in money, possibly, at least, is small. This is a suit by a State for an injury to it in its capacity of quasi-sovereign. In that capacity the State has an interest independent of and behind the titles of its citizens, in all the earth and air within its domain. It has the last word as to whether its mountains shall be stripped of their forests and its inhabitants shall breathe pure air. It might have to pay individuals before it could utter that word, but with it remains the final power. The alleged damage to the State as a private owner is merely a makeweight, and we may lay on one side the dispute as to whether the destruction of forests has led to the gullying of its roads. * * *
>
> They (states) did not renounce the possibility of making reasonable demands on the ground of their still remaining quasi-sovereign interests; and the alternative to force is a suit in this court. * * *

> The States by entering the Union did not sink to the position of *private owners subject to one system of private law.* * * * Without excluding the considerations that equity always takes into account, we cannot give the weight that was given them in argument to a comparison between the damage threatened to the plaintiff and the calamity of a possible stop to the defendants' business, the question of health, the character of the forests as a first or second growth, the commercial possibility or impossibility of reducing the fumes to sulphuric acid, the special adaptation of the business to the place.
>
> It is a fair and reasonable demand on the part of a sovereign that the air over its territory should not be polluted on a great scale by sulphurous acid gas, that the forests on its mountains, be they better or worse, * * * should not be further destroyed or threatened by the act of persons beyond its control, that the crops and orchards on its hills should not be endangered from the same source. If any such demand is to be enforced this must be, notwithstanding the hesitation that we might feel if the suit were *between private parties*, and the doubt whether for the injuries which they might be suffering to their property they should not be left to an action at law. * * *
>
> Whether Georgia by insisting upon this claim is doing more harm than good to her own citizens is for her to determine. The possible disaster to those outside the State must be accepted as a consequence of her standing upon her extreme rights."

The cause of the suit was an insistence upon the right of Georgia to be protected in the reasonable enjoyment of her rights of sovereignty. The plaintiff prevailed. The case did not proceed upon the theory of the litigation being between private parties, but upon the fact of peculiar rights inhering in litigants with sovereign powers.

Rickey Land & Cattle Co. vs. Miller & Lux, 218 U. S., 258, decided in 1910, opinion by Mr. Justice Holmes, was an action between private parties in reference to the waters of an interstate stream and the character of that action is carefully distinguished from a case wherein the sovereignty itself is insisting upon its right to the waters of a stream. Miller & Lux, the corporation using the water of Walker River in Nevada, claimed rights therein. Two branches of the river rise in California and unite in Nevada above Miller & Lux. Rickey used water of both branches in California and claimed rights superior to parties lower down. In 1902 Miller & Lux brought suit in the

circuit court for the district of Nevada against Rickey and certain other defendants to enjoin interference with its use of water. Rickey pleaded that the diversion by him was in California and later answered. After appearing, he organized the petitioning corporation and conveyed his rights in California to it. In 1904 this corporation began two actions in the state court of California against Miller & Lux, and others, to quiet its title to certain water rights on the west fork and east fork, supra. In December, after they were served with process in the last mentioned suit, other defendants in the bill brought by Miller & Lux brought a cross bill against Rickey to establish their priorities. In 1906 the bills in these present cases were brought by Miller & Lux to restrain proceedings in the California actions on the ground that the Federal Court had acquired jurisdiction before the California actions were begun. Injunctions were granted. *Inter alia* the court said:

> "The petitioner contends that there is no conflict of jurisdiction, and that the proceedings in the California court should go on. Its argument is this: When a right is asserted in favor of land in one jurisdiction over land in another, different principles are involved from those that suffice when both parcels are subject to the same law. When such rights have been recognized, it has been on the ground of an assumed 'concurrence between the two states, the one, so to speak, offering the right, the other permitting it to be accepted. Mannville Co. vs. Worcester, 138 Mass., 89.' Missouri vs. Illinois, 200 U. S., 496, 521. But still there are two parcels of land subject to different systems of law; and although the rights and liabilities in respect of each may require a consideration of the other if they are to be dealt with completely, the fact remains that each may be regulated by the state where the land lies according to its sovereign will. Kansas vs. Colorado, 206 U. S. 46, 93. If, then, the courts of one state are about to deal with one parcel they should not be indirectly interfered with by a foreign court that has no power to control the use of the *res*. It is said to be a general principle that apart from some privity, such as is created by contract, trust, or fraud, courts of equity recognize the impropriety of using their power over the person to achieve such a result. (Citing cases.) It is conceivable, to be sure, that the decisions of this court may determine that the States have rights as against each other *in invitum* in streams that flow through the land of both. Kansas vs. Colorado, 206 U. S. 46, 84; Missouri vs. Illinois, 200 U. S. 496, 519-20. These rights may vary according to the

system of law required by natural conditions. They may be more or less analogous to common law rights between upper and lower proprietors, where irrigation is not necessary, as in most of the older states. See New York vs. Pine, 185 U. S. 93, 96. There may be some, perhaps limited, right of appropriation in the upper state, at least in the watershed of the stream, where irrigation is the condition of using the land. See Kansas vs. Colorado, 206 U. S., 46, 100-104, 117. *But whatever this court may decide, if a private owner should derive advantage from such a decision it would not be in his own right, but by reason of and subordinate to the rights of his state*, and those rights, the petitioner insists, can, or at least should be, determined only in a suit brought by the state itself. * * * To affect a purchaser with a suit against his vendor, it is said that at least the *res* must be within the territorial jurisdiction of the court in which the suit is brought. See Fall vs. Eastin, 215 U. S. 1.

We are of the opinion that the petitioner fails to establish the conclusion for which it contends. The alleged rights of Miller and Lux involve a relation between parcels of land that cannot be brought within the same jurisdiction. This relation depends as well upon the permission of the laws of Nevada as upon the compulsion of the laws of California. It is true that the acts necessary to enforce it must be done in California, and require the assent of that state so far as this court does not decide that they may be demanded as a consequence of whatever right, if any, it may attribute to Nevada. But, leaving the latter possibility on one side, if California recognizes private rights that cross the border line, the analogies are in favor of allowing them to be enforced within the jurisdiction of either party to the joint arrangement."

The decree below was approved. The court, however, makes it clear that the suit was between private parties and that the right of land owned by a private party in Nevada to claim a servitude upon the California lands was based upon the assumed consent of California. Particularly worthy of note is the contention of petitioner, the reasons assigned in which the court does not apparently differ from but only differs in the conclusion. In this argument it is recognized that the rights of individuals in waters of an interstate stream are subordinate and inferior to the rights that the sovereign may claim when it asserts its own.

Bean vs. Morris, 221 U. S., 485, decided in 1910, opinion by Mr. Justice Holmes, is again a suit between private parties over the waters of an interstate stream, and the learned justice keeps in bold relief that there is a distinction between such a contention when the litigants are sovereign states. The suit was by respondent Morris to prevent petitioners from so diverting the water of Sage Creek in Montana as to interfere with an alleged prior right of Morris by appropriation in Wyoming. Afterwards Howell was allowed to intervene and make similar claim. Sage Creek, non-navigable, joins Stinking Water in Wyoming, the latter flows into Big Horn and then back into Montana and unites with the Yellowstone. Decree went for Morris and for Howell subject to the claim of Morris, both parties being prior in time and right to the petitioners. It was admitted in argument that but for the fact that the prior appropriation was in Wyoming and the interference in Montana, the decree would be right. The court, *inter alia*, said:

> "So we pass at once to the question of private water rights as between users in different states.
>
> We know no reason to doubt, and we assume, that, subject *to such rights as the lower state might be decided by this court to have*, and to vested private rights, if any, protected by the Constitution, the State of Montana has full legislative power over Sage Creek while it flows within that state. Kansas vs. Colo., 206 U. S., 46, 93-95. Therefore, *subject to the same qualifications*, we assume that the concurrence of the laws of Montana with those of Wyoming is necessary to create easements, or such private rights and obligations as are in dispute, across their common boundary line. Missouri vs. Illinois, 200 U. S. 496, 521; Rickey Land and Cattle Company vs. Miller and Lux, 218 U. S., 258, 260. But with regard to such rights as came into question in the older States, *we believe that it always was assumed, in the absence of legislation to the contrary*, that the States were willing to ignore boundaries, and allowed the same rights to be acquired from outside the state that could be acquired from within." (Mannville Co. vs. Worcester, 138 Mass., 89, and other cases cited.) "There is even stronger reason for the same assumption here. Montana cannot be presumed to be intent on suicide, and there are as many if not more cases in which it would lose as there are in which it would gain, if it invoked a trial of strength with its neighbors. * * * The doctrine of appropriation has prevailed in these regions probably from the first moment that they knew

any law, and has continued since they became territory of the United States.

It was recognized by the statutes of the United States, while Montana and Wyoming were such territory * * * and is recognized by both States now. Before the state lines were drawn, of course, the principle prevailed between the lands that were destined to be thus artificially divided. Indeed, Morris had made his appropriation before either state was admitted to the Union. The only reasonable presumption is that the States, upon their incorporation, continued the system that had prevailed theretofore, *and made no changes other than those necessarily implied or expressed.* * * * It follows from what we have said that it is unnecessary to consider what limits there may be to the powers of an upper State, if it should seek to do all that it could. The grounds upon which such limits would stand are referred to in Rickey Land and Cattle Company vs. Miller and Lux, 218 U. S., 258, 261."

The decree below is affirmed, the court finding that the Wyoming lands held a servitude upon the Montana lands upon the theory that as between private parties, the State of Montana was presumed to have consented, but is strongly suggestive that the right to appropriate at the expense of Montana was subject to the will of Montana as a state and such limits as might be put upon her sovereignty by the doctrine of interstate waters.

The great case in which the rights of sovereign states in the waters of an interstate stream, where the problems of irrigation had place, are presented, discussed and decided in Kansas vs. Colorado, 206 U. S., 46, decided in 1906, opinion by Mr. Justice Brewer. Of this case a great lawyer and an eloquent senator from this commonwealth recently said in the Senate of the United States:

> "The decision in the case of Kansas vs. Colorado is one of the great opinions of the Supreme Court of the United States. To my mind it easily ranks with the most notable judicial pronouncements of that great tribunal and, as time passes, I believe that fact will be more and more recognized; perhaps I should say particularly with reference to its definition of the powers of the government and the distinction it so clearly draws between those powers and the reserved powers of the states."

Kansas brought suit against the State of Colorado and a number of private ditch companies for the purpose of enjoining

them from diverting waters from the Arkansas River. The State of Colorado appeared insisting upon her rights in the stream as one of her sovereign rights. The ditch companies answered, setting up their priorities. Proof was adduced as to the priorities of certain ditches in Kansas earlier in point of time than Colorado ditches and which Kansas ditches, the evidence showed, were deprived of water by the Colorado diversions. The Government of the United States intervened. Its bill of intervention was dismissed upon the ground that it did not own the waters of the Arkansas River, that it had no rights therein as the question of navigation did not arise, and it was dismissed from the suit. It is difficult to understand, after the ruling in this great and luminous case, that the Government of the United States still insists, through some of its departments, on being interested in non-navigable streams. It may be said, however, that when waters are sought to be appropriated from the streams of any state for any national government project, the National Government deems it to be the safe course to comply with the state laws as any other consumer would in his efforts to acquire rights by prior appropriation in the waters of a stream.

The careful reasoning of the court in approaching its ruling in this case, that it was keeping constantly before its mind in deciding the grave question it was ruling between two sovereign commonwealths, the principle laid down by the court in the sewage case, Missouri vs. Illinois, 200 U. S., 521, wherein it is said:

> "Before this court ought to intervene the case should be of serious magnitude, clearly and fully proved, and the principle to be applied should be one which the court is prepared deliberately to maintain against all considerations on the other side."

In perhaps no case in the history of this great court has there been shown greater and more thoughtful care in guarding the rights of the states than in this case of Kansas vs. Colorado. An unjust decision might have destroyed the agricultural resources of a state which, resting upon the crest of the continent where the waters begin which flow to the east, to the west, to the north and the south, and where a declaration of the applicability of the riparian rights would have visited with destruction not only the development of the Arkansas valley, but the other great valleys of Colorado, the court, conforming to the principles of common law, international law and state law, rendered a decision which fully protected the rights of the litigants and declared no precedent that would be destructive to the rights of the states in future litigation.

The pith of this ruling, when fully considered, is that the common law adjusted itself to conditions as it found them, aiming to administer the highest justice between man and man; that applying its principles and all other principles of jurisprudence in the relations between the states, it was the controlling purpose of the court to work out justice; that as to this interstate stream in the reasonable exercise of their respective sovereign rights, each of the states was entitled to a reasonable part of the waters; that the court would not consider the question of private rights among the ditch companies; that the disposition of the rights of the two states would be a disposition of the rights of the private parties, for the reason that the rights of the private parties were subordinate to the rights of the states; that if the court found, as it did find, that Colorado was not diverting from this stream any more than a reasonable part of the waters of the stream and for that reason the bill must be dismissed, that the rights of the private ditch companies and their priorities were immaterial.

In conclusion, the court held that Colorado was not taking more than a reasonable part of the waters of this interstate stream; that she was entitled to take a reasonable part in the exercise of her rights of sovereignty; that even though this exercise of a right of sovereignty worked some prejudice to Kansas, no legal wrong was done; that if, at any time it might appear that Colorado was taking more than a reasonable part of the waters of this stream, Kansas could justly come again. The bill was dismissed.

Excerpts from this decision pertaining to the question before us are:

> "But it is useless to pursue the inquiry further in this direction. It is enough for the purposes of this case that each State has full jurisdiction over the lands within its borders, including the beds of streams and other waters." 93.
>
> "But when the States of Kansas and Colorado were admitted into the Union they were admitted with the full powers of local sovereignty which belonged to other States, * * * and Colorado by its legislation has recognized the right of appropriating the flowing waters to the purposes of irrigation." 95.
>
> "'Can it be that the great multitude of interstate commercial transactions are freed from the burdens created by the common law as so defined, and are subject to no rule except that to be found in the statutes of Congress? We are clearly of opinion that this cannot be so, and that the principles of the common law are oper-

ative upon all interstate commercial transactions except so far as they are modified by Congressional enactment.'" 96.

"For after all, the common law is but the accumulated expressions of the various judicial tribunals in their efforts to ascertain what is right and just between individuals in respect to private disputes." 97.

"Nor is our jurisdiction ousted, even if, because Kansas and Colorado are States sovereign and independent in local matters, the relations between them depend in any respect upon principles of international law. International law is no alien in this tribunal." 97.

"'Sitting, as it were, as an international, as well as a domestic tribunal, we apply Federal law, state law, and international law, as the exigencies of the particular case may demand.'

One cardinal rule, underlying all the relations of the States to each other, is that of equality of right. Each State stands on the same level with all the rest." 97.

"Yet, whenever, as in the case of Missouri v. Illinois, 180 U. S. 208, the action of one State reaches through the agency of natural laws into the territory of another State, the question of the extent and the limitations of the rights of the two States becomes a matter of justiciable dispute between them, and this court is called upon to settle that dispute in such a way as will recognize the equal rights of both and at the same time establish justice between them. In other words, through these successive disputes and decisions this court is practically building up what may not improperly be called interstate common law." 97, 98.

"It will be perceived that Kansas asserts a pecuniary interest as the owner of certain tracts along the banks of the Arkansas and as the owner of the bed of the stream. We need not stop to consider what rights such private ownership of property might give." 98.

"The action complained of is state action."

"The controversy arises, therefore, above a mere question of local private right and involves a matter of state interest, and must be considered from that standpoint." 99.

"May we not consider some appropriation by Colorado of the waters of the Arkansas to the irrigation and reclamation of its arid lands as a reasonable exercise of its sovereignty and as not unreasonably trespassing upon any rights of Kansas?" 102.

"What is such a just and reasonable use, may often be a difficult question, depending on various circumstances. To take a quantity of water from a large running stream for agricultural or manufacturing purposes, would cause no sensible or practicable diminution of the benefit, to the prejudice of a lower proprietor; whereas, taking the same quantity from a small running brook passing through many farms, would be of great and manifest injury to those below, who need it for domestic supply or watering cattle; and therefore it would be an unreasonable use of the water, and an action would lie in the latter case and not in the former. It is, therefore, to a considerable extent a question of degree; still, the rule is the same, that each proprietor has a right to a reasonable use of it, for his own benefit, for domestic use, and for manufacturing and agricultural purposes." 103-4.

"At one time there were some irrigating ditches in these western (Kansas) counties, which promised to be valuable in supplying water and thus increasing the productiveness of the lands in the vicinity of the stream, and it is true that those ditches have ceased to be of much value, the flow in them having largely diminished.

It cannot be denied in view of all the testimony * * * that the diminution of the flow of water in the river by the irrigation of Colorado has worked some detriment to the southwestern part of Kansas, and yet when we compare the amount of this detriment with the great benefit which has obviously resulted to the counties in Colorado, it would seem that equality of right and equity between the two States forbids any interference with the present withdrawal of water in Colorado for purposes of irrigation." 113-114.

"Summing up our conclusions, we are of the opinion * * * that the appropriation of the waters of the Arkansas by Colorado, for purposes of irrigation, has diminished the flow of water into the State of Kansas; that the result of that appropriation has been the reclamation of large areas in Colorado, transforming thousands of acres into fertile fields and rendering possible their occupation and cultivation when otherwise they would have continued barren and unoccupied; that while the influence of such diminution has been of perceptible injury to portions of the Arkansas Valley in Kansas, particularly those portions closest to the Colorado line, yet to the great body of the valley it has worked little, if any, detriment, and regarding the interests of both States and the right of each to receive benefit through irrigation

and in any other manner from the waters of this stream, we are not satisfied that Kansas has made out a case entitling it to a decree. At the same time it is obvious that if the depletion of the waters of the river by Colorado continues to increase there will come a time when Kansas may justly say that there is no longer an equitable division of benefits and may rightfully call for relief against the action of Colorado, its corporations and citizens in appropriating the waters of the Arkansas for irrigation purposes.

The decree which, therefore, will be entered will be one dismissing the petition of the intervener, without prejudice to the rights of the United States to take such action as it shall deem necessary to preserve or improve the navigability of the Arkansas River. The decree will also dismiss the bill of the State of Kansas as against all the defendants, without prejudice to the right of the plaintiff to institute new proceedings whenever it shall appear that through a material increase in the depletion of the waters of the Arkansas by Colorado, its corporations or citizens, the substantial interests of Kansas are being injured to the extent of destroying the equitable apportionment of benefits between the two States resulting from the flow of the river." 117-118.

The ruling was that each state was entitled to an equitable apportionment of benefits between the two states resulting from the flow of the river, which equitable apportionment of benefits could only be secured through an equitable apportionment of the waters of this interstate stream.

The doctrine of prior appropiation has at all times obtained in Colorado and Wyoming.

> "The doctrine of appropriation has prevailed in this region probably from the first moment that they knew of any law, and has continued since they became territory of the United States."
>
> Bean vs. Morris, 221 U. S. 485.

It was recognized by the statutes of the United States while Colorado and Wyoming were territories.

> United States vs. Rio Grande, 174 U. S., 690.
>
> Gutierres vs. Albuquerque, 188 U. S., 545.

When Colorado became a state in 1876, in its sovereign capacity it became the owner, for the benefit of its people in common, of all the waters of the streams of the state.

See—

Walbridge vs. Robinson, 22 Ida., 240.

Also—

Colorado Enabling Act, Colorado Constitution, and Proclamation of President, supra.

Colorado, in this suit, insists upon her claim to divert 91,000 acre feet of water of this interstate stream. This is a reasonable exercise of her rights of sovereignty as to this interstate stream. She requires the water for necessary public uses. It will produce larger results within her boundaries than elsewhere. She is not unreasonably trespassing upon Wyoming in thus reasonably exercising her rights. The only reasonable way in which this right can be availed of is to apply the waters to lands lying within another watershed. The right to carry water to another watershed is necessary for its beneficial use within the State of Colorado.

In Coffin et al. vs. Left Hand Ditch Co., 6 Colo., 443, it is said:

> "The doctrine of priority of right by priority of appropriation for agriculture is evoked, as we have seen, by the imperative necessity for artificial irrigation of the soil. And it would be an ungenerous and inequitable rule that would deprive one of its benefit simply because he has, by large expenditure of time and money, carried the water from one stream over an intervening watershed and cultivated land in the valley of another. It might be utterly impossible, owing to the topography of the country, to get water upon his farm from the adjacent stream; or if possible, it might be impracticable on account of the distance from the point where the diversion must take place and the attendant expense; or the quantity of water in such stream might be entirely insufficient to supply his wants. It sometimes happens that the most fertile soil is found along the margin or in the neighborhood of the small rivulet, and sandy and barren land beside the larger stream. To apply the rule contended for would prevent the useful and profitable cultivation of the productive soil, and sanction the waste of water upon the more sterile lands. It would have enabled a party to locate upon a stream in 1875, and destroy the value of thousands of acres, and the improvements thereon, in adjoining valleys, possessed and cultivated for the preceding decade. Under the principle contended for, a party owning land ten miles from the stream, but

in the valley thereof, might deprive a prior appropriator of the water diverted therefrom whose lands are within a thousand yards, but just beyond an intervening divide." 449-450.

In the syllabus of the same case and supported by the opinion, it appears:

"The right to water acquired by prior appropriation is not in any way dependent upon the *locus* of its application to the beneficial use designed."

Other cases in Colorado announcing the same doctrine are:

Thomas vs. Guiraud et al., 6 Colo., 530-532.

Hammond vs. Rose et al., 11 Colo., 524-526.

Openlander vs. Left Hand Ditch Co., 18 Colo., 142-144.

Coffin vs. Left Hand Ditch Co. is cited with approval in Moyer vs. Preston, 6 Wyo., 308, 313, 321; Willey et al. vs. Decker, 11 Wyo., 496, 516, 528, 530.

The Left Hand Ditch case is cited with approval in support of the doctrine that water may be diverted to non-riparian lands

in Boquillas Cattle Co. vs. Curtis Co., 213 U. S., 339, 345; also 181 Fed., 1014, 1015.

An exhaustive discussion of the practise and the law of inter-watershed diversions is set forth in Vol. 2 of this brief.

We respectfully submit that when the law is applied to the facts in this case, it appears that the appropriations by Colorado to the irrigation and reclamation of its arid lands of 91,000 acre feet of the run-off of the Laramie River is but a reasonable exercise of its sovereignty and does not constitute an unreasonable trespass upon the rights of Wyoming, and further, that she is simply availing herself of her own great natural resources in making this proposed diversion. The action should be dismissed at the cost of complainant.

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APPENDIX

LIST OF DEFENDANTS' EXHIBITS.

The complainant's exhibits are designated by the letters of the alphabet. The defendants' exhibits are numbered.

Exhibits:

1. Map of the Laramie and Cache la Poudre Rivers, attached to the answer of the corporate defendants.
2. Map showing irrigated lands, Wheatland, Bordeaux and Sybille tracts.
21. Sketch Map, drainage area of Western States.
22. Sketch Map, Jumna Western and Eastern Canals, India.
23. Map, Punjab Project, India.
24. Map, United Provinces of Agra and Oudh, India.
25. Map, Periyar Project, India.
26. Map, Madras Presidency, India.
27. Map, Bouches du Rhone, France.
28. Map, Carpentras Canal, France.
29. Map, Gap Canal, France.
30. Photograph, Aqueduct, Pont du Gard, France.
31. Photograph, Tunnel, Aqueduct Pont de Gard, France.
32. Photograph, Masonry Aqueduct Craponne Canal, France.
33. Photograph, Aqueduct Carpentras Canal, France.
34. Photograph, Aqueduct Carpentras Canal, France.
35. Sketch Map, Cavour Canal, Italy.
36. Sketch Map, Villoresi Canal, Italy.
37. Sketch Map, White Mud River Project, Canada.
38. Sketch Map, Elbow River Project, Canada.
39. Sketch Map, Red Deer Project, Canada.
40. Photograph, Head-works Cavour Canal, Italy.
41. Photograph, Intake, Cavour Canal.
42. Photograph, Naviglio Grande, Italy.
43. Sketch Map, Strawberry Valley Project, U. S. Reclamation Service, Utah.
44. Map, Milk River Project, Montana.
45. Sketch Map, Los Angeles Aqueduct.
46. Sketch Map, drainage areas, Colorado, Montana, Wyoming.
47. Map, Powder River Project, Wyoming.
48. Map, irrigated land, Powder River Project.
49. Three Sketch Maps, Inter-watershed diversions, Wyoming.
50. Sketch Map, Inter-watershed diversion, Wyoming.
51. Copy of map and statement, Laramie-Poudre Tunnel and collection ditches, filed in office State Engineer, Colo., October 6, 1904.

52-72. Photographs of early work on Greeley-Poudre System on the Laramie River, 1902-1904.

73. Photograph, Skyline Canal.
74. Copy of map and statement, Link Lake Ditch and feeders, filed in State Engineer's office, Colo., Oct. 15, 1902.
75. Copy of map, East Fork Ditch and Reservoir, filed in State Engineer's office, Colo., May 9, 1904.

76-85. Photographs of upper works of Greeley-Poudre System on Laramie River, 1907-1912.

86-104 Blue print diagrams, based on Census Reports, decades 1870 to 1910, inclusive, comparing Larimer and Weld counties, Colorado, with Laramie and Albany counties, Wyoming,—size, population, rural population, agricultural production and live stock.

105. Plat showing minimum temperatures, 1893 to 1912, inclusive, Greeley, Colo., and Laramie, Wyo.

106-112. Photographs showing crop and soil conditions, Laramie Plains, Wyoming.

113. Tabulation, flow of water from Cache la Poudre River to South Platte River, 1909-1913.

Exhibits:

114. Plane table survey plats, Laramie Plains.
115. Album of Photographs of diversion works on Big and Little Laramie Rivers, Laramie Plains, Wyoming.
116. Album of Photographs, farm and ranch improvements, Laramie Plains, Wyoming.
117. Tabulation, irrigated area classified, Little Laramie Valley, Wyoming.
118. Tabulation, irrigated area classified, Big Laramie Valley, Laramie Plains, Wyoming.
119. Album of Photographs. Improvements under Larimer County Canal, Colorado.
120. Album of Photographs, Improvements under Larimer and Weld Canal, Colorado.
121. Album of Photographs, Agricultural Industries, Poudre Valley.
122. Album of Panoramic Photographs, Wheatland and Laramie Plains areas in Wyoming, and Poudre Valley area in Colorado.
123. Table, discharge, Cache la Poudre River at mouth of canon, 1881-1913.
124. Table, discharge, Cache la Poudre at mouth of canon, showing additions and diversions above gauging station.
125. Table, discharge Laramie River at Glendevey, Colo.
126. Table, discharge Laramie River at Decker's and Boswell's (State line).
127. Table, run-off, Laramie River at Wood's Landing, Wyo., and Skyline and Divide Canal diversions.
128. Table, discharge, Laramie River, Wood's Landing, Wyo., 1889-1913.
129. Table, discharge, Laramie River at Boswell's (State line) and Wood's Landing, showing inflow between stations.
130. Maps of irrigated area, Laramie River Valley in Colorado.
131. Table, discharge, Little Laramie River at Hatton, Wyo.
132. Diagram, Laramie River, Skyline Ditch to Wood's Landing, 1912.
133. Diagram showing flow and use, Little Laramie River, Hatton to Two Rivers, Wyo., 1912.
134. Diagram showing flow and use, Laramie River from Two Rivers to Look Out, Wyo., 1912.
135. Mass diagrams, Wheatland Reservoir, Wyoming, 1912.
136. Mass diagram, supply and use, Big and Little Laramie Rivers, 1912.
137. Mass diagram, supply and diversions, Laramie River, Skyline Canal to Wood's Landing, Wyo., 1913.
138. Diagram, supply and use, Little Laramie River, from Fillmore to Two Rivers, 1913.
139. Diagram, Laramie river, supply and use, Two Rivers to Look Out, Wyo., 1913.
140. Mass diagram, Wheatland Reservoir, Wyoming, 1913.
141. Mass diagram, Big and Little Laramie Rivers, supply and use, 1913.
142. Diagram, flow and diversions, Laramie River to State line.
143. Table, discharge, Big Laramie River at Two Rivers, Wyo., 1909-1913.
144. Table, discharge, Little Laramie River at Two Rivers, 1909-1913.
145. Table, discharge, Laramie River at Uva, Wyoming.
146. Tabulation showing sugar beet industry in Colorado.
147-153. Letters to and replies from State Engineers of various Western States, inter-watershed diversions.
154-155. Soil Maps, U. S. Soil Survey, Laramie Plains, Wyo.
156. Photographs showing snow-fall, Medicine Bow Range, Colorado and Wyoming.
157. Chart, discharge, Little Laramie River at Fillmore, Wyo., 1912.
158. Chart, discharge, Laramie River at Boswell's (State line), 1912.
159-178. Certified copies applications and permits for irrigation projects diverting water from the Laramie River in Wyoming, 1908 and subsequent.
179. Copy, Decree adjudicating priorities, Water District No. 43 (Laramie River, Colorado).

NOTE.—Exhibits 3 to 20, inclusive, consist of various data produced on cross-examination by witnesses for the complainant. These were identified but not introduced.

Exhibits 22 to 50, inclusive, show inter-watershed diversions in India, Italy, France, Canada and United States.

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JAMES D. MAHER

In the Supreme Court of the United States

October Term, 1917

In Equity

THE STATE OF WYOMING,
COMPLAINANT,

vs.

THE STATE OF COLORADO, The Greeley-Poudre Irrigation District, and The Laramie-Poudre Reservoirs and Irrigation Company,
DEFENDANTS.

BRIEF IN ANSWER TO THE BRIEF OF THE UNITED STATES.

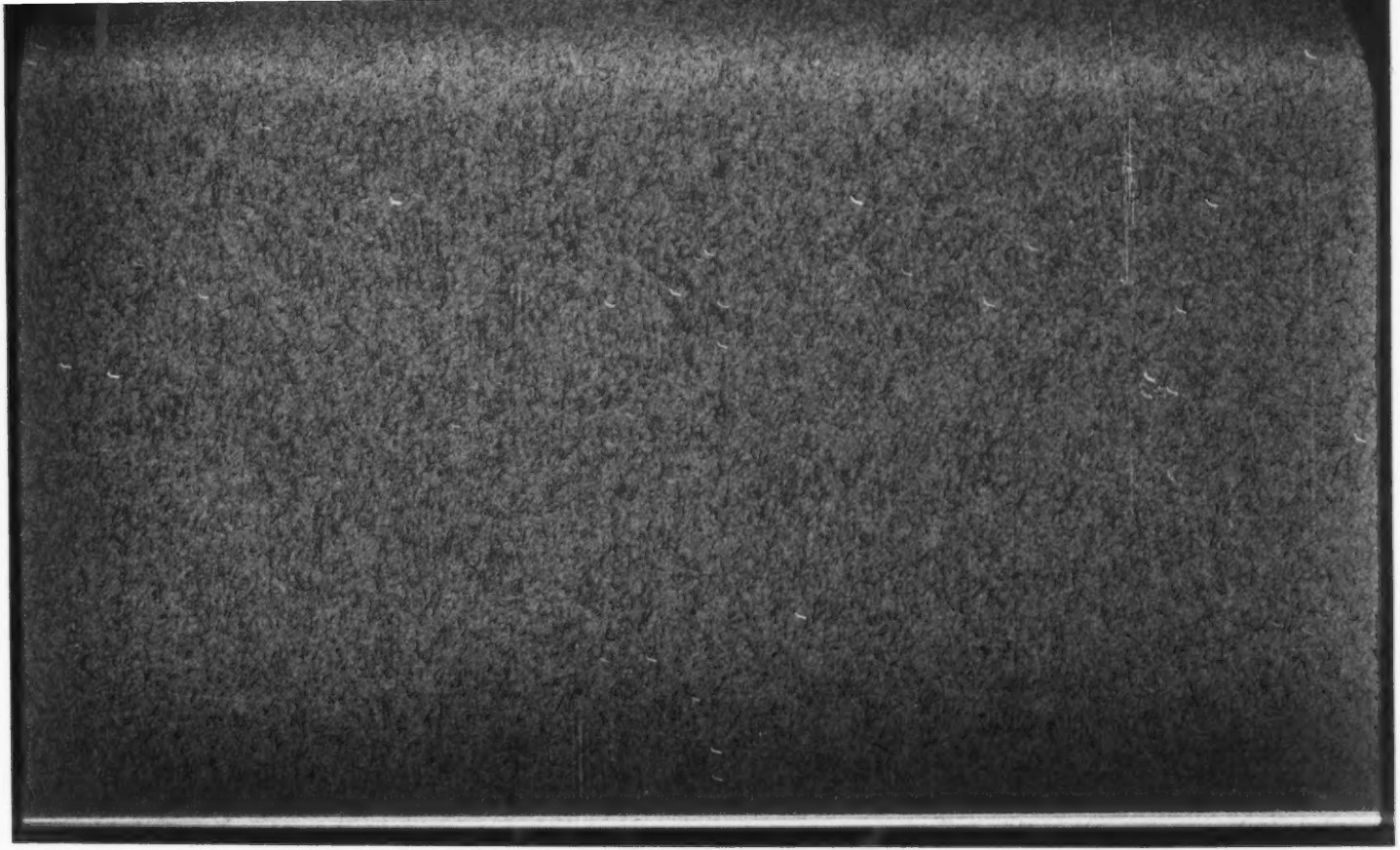
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BRIEF IN ANSWER TO THE BRIEF OF THE UNITED STATES.

A DISCUSSION OF THE CONTENTION OF COUNSEL FOR THE UNITED STATES THAT THE WATERS OF THE LARAMIE RIVER ARE THE PROPERTY OF THE UNITED STATES AND WHOLLY REMOVED FROM STATE CONTROL OR THE EFFECT OF LITIGATION BETWEEN WYOMING AND COLORADO.

As we understand the brief of the counsel for the Government, they concede that if the controversy here were between States in which the United States

never owned any property, as, for example, Massachusetts and Connecticut, private rights in an interstate stream would be limited by the division made between the States and either stand or fall with the larger right of the State, upon the theory that the States have rights against each other *in invitum*. To this extent, at least, they agree with the Colorado contention, but they say that the Colorado contention falls to the ground when once it is conceded that the water rights involved come from the United States and are protected by its sovereign power, and the main object of their brief is to prove that water rights in Wyoming and Colorado come from the United States and are protected by its sovereign power, and that the States have no right in or jurisdiction over the waters flowing within their boundaries except to the extent that they may exercise over them and the appropriators the police power which belongs to them as States. If this be true, then if police power is to be given the restricted meaning implied by the argument, counsel are doubtless right in saying that Wyoming has no proprietary or sovereign interests to assert, and Colorado has no proprietary or sovereign interests to defend. Using their own language, "the ungranted waters of the Laramie River, if there are any, are the property of the superior sovereign, the United States, and so are wholly removed from State control or the effect of litigation between the States." Wyoming, therefore, presents no justiciable controversy to this Court. If the appropriators in Wyoming and Colorado derived their rights respectively from the United States and the States have no proprietary or

sovereign interests to protect, it follows that the claims of appropriators in Wyoming against appropriators in Colorado must be settled by separate private controversies and cannot be settled in the mass by any State action.

It is a peculiar quality of rights by appropriation that each right has its own individual history and that there is no common tie between appropriators so far as the initiation and maintenance of their rights are concerned. The State, therefore, could do no more, as *parens patriae,* acting in behalf of appropriators within their limits, than make precisely the proof that they would severally be required to make in their own behalf in private litigation. In other words, any action by the State would be in behalf of a purely private right, and thus in violation of the prohibition applied in such cases.

New Hampshire vs. Louisiana and Others, 108 U. S. 76, 89.
Louisiana vs. Texas, 176 U. S. 1, 16.

Counsel say that by virtue of its acquisition of lands west of the Mississippi the United States has the right to give to individuals a vested interest in waters flowing in innavigable streams, with the right to use and protect it as granted unless and until it is condemned and paid for and that Congress intends that waters thus granted shall be effective regardless of state lines. They make no attempt to solve the problem which the Court desires to have solved if their contention should not be granted. They seek to give a practical as well as a legalistic foundation for their contention by the claim that

otherwise the reclamation projects of the Government cannot be carried out and that the interest of the Government in its lands cannot be preserved unless it has the right to control the disposition of the streams coursing through them.

It is admitted by counsel that Colorado's theory has not as yet offered any obstacle in either case, and it seems also to be admitted that it has been the policy of the Government heretofore to allign itself with other appropriators of water, taking its proper place as an appropriator, and not as a sovereign or proprietary owner, with all other appropriators, senior and junior, just as though it were in every respect bound to conform to the laws of the State, the same as other appropriators. That in respect to the reclamation of its lands, the Government acts in a proprietary and not sovereign way is decided in Twin Falls Land Co. vs. Foote, 192 Fed. 583, Standfield vs. Umatilla River Water Users' Assn., 192 Fed. 596, and in the very recent case of In re Waters of Umatilla River, 168 Pac. 922.

If the Government intends in the carrying out of its reclamation projects or in the use of water on its lands to respect the rights of prior appropriators, it is a matter of no practical importance to it whether the source of title to water by appropriation is the general Government or the State in which the Government plans are carried out or the Government lands may lie. Nor does the existence of the state line have any influence except the possibility of a controversy if water should be stored in one State, to be used in another. But such a contro-

versy is just as possible between the Government and individual appropriators as between the Government and the State. In fact, so far as the Government is concerned in this or in any other controversy concerning the use of the waters of innavigable streams, the contention of counsel is without practical value. It is no more hampered by the laws of the States created out of the public domain in which the doctrine of appropriation prevails than it is in the original States, in which the doctrine of riparian rights prevails, nor is it inconsistent with the interests of the General Government in such streams that the State should have the primary right to make them conserve the general welfare of the State. It seems to us that, so far as the United States is concerned, Mr. Long is quite right in saying that the question of what is the foundation of the right to appropriate is of little practical importance and the discussion thereof largely academic.

But as it is the purpose of this Court to obtain all light possible upon the subject and to formulate some definite rule for the disposition of controversies between States concerning their respective rights in interstate streams, and as Colorado claims that it possesses the sovereign right in its streams, as against the contention of counsel, it becomes our duty to give due consideration to what is advanced upon behalf of the Government.

Is it true that in the States created out of the public domain where irrigation is practiced and where the doctrine of appropriation as opposed to the doctrine of riparian rights prevails, the United States is still the sovereign or proprietary owner

of the natural streams, that all titles by appropriation are derived from it, and that it retains and may exercise plenary control and administration of such streams to the exclusion, if need be, of the particular States in which the streams lie? Is it true that all that has been done by the several States in the enactment of laws concerning the acquisition and use of water and the administration and distribution of the same has been done not in virtue of any inherent sovereign right of the States, but merely by force of the acquiescence of the United States? Is it true that the only inherent power of States in declaring that the waters must be beneficially used and supervising the same to effectuate that purpose, is that power which is denominated the police power? In other words, do the States maintain with respect to their natural streams the relation of mere agents of the General Government, who by the acquiescence of the Government are permitted to provide the machinery for the initiation and maintenance of rights by appropriation and the regulation and control thereof?

As a preface to the discussion of the subject that is to follow, we call attention to the statement of counsel, page 105, that "The question whether the United States or the States own the waters of innavigable streams in the West has never been directly passed upon by this Court." If this be true, the Court will be at liberty to make such disposition of the subject as the present stage of irrigation development and the material interests of the States demand, free from the embarrassment of primitive or obsolete practices or legal conceptions and with-

in the maxim *salus populi suprema lex,* and it will be from that standpoint that we shall finally present our views.

For the present, however, we shall contest the correctness of the statement. We first refer to the case of *Kansas vs. Colorado,* 206 U. S. 46, because that presented a controversy in which it was necessary to say whether the States possessed any sovereign interest in their waters. If the present Government counsel are correct, the waters of the Arkansas River belong to the United States and "are wholly removed from State control or the effect of litigation between the States." It must not be overlooked that the Government was represented by counsel in that case as well as in this, and that the special ground of the Government's interest in that controversy was the protection of its reclamation projects. The Government's contention did not fail because it was not presented or because it was overlooked. The logical conclusion from the argument of the present counsel, which they draw for themselves and which seems correct, is that if the waters belong to the United States the States have no justiciable interest in them as such, but the Court in *Kansas vs. Colorado* found that there was such justiciable controversy, which would imply that they rejected the present contention and that the basis of their decision was the recognition of some rights in the States greater than counsel are now willing to concede. In the opinion in that case the Court inquires whether the question is one simply between States or is a matter subject to National legislative regulation

and is the flow of the stream subject to the superior authority and supervisory control of the United States. The Court puts it thus:

> "In other words, is the determination of the right of the two States *inter sese* in regard to the flow of the waters of the Arkansas River subordinate to a superior right on the part of the National Government to control the whole system of the reclamation of arid lands?"

As to the claims made in behalf of the reclamation projects generally the Court answers that as no power has been granted to engage in such enterprise, none can be exercised. It, however, concedes the authority to reclaim proportioned to the lands still in Government ownership by virtue of the power conferred by the Constitution upon Congress, "to dispose of and make all needful rules and regulations respecting its property." But this is at once qualified by the following statement:

> "We do not mean that its legislation can override State laws in respect to the general subject of reclamation. While arid lands are to be found mainly, if not only, in western and newer States, yet the powers of the National Government within the limits of those States are the same (no greater and no less) than those within the limits of the original thirteen, and it would be strange if in the absence of a definite grant of power the National Government could enter the territory of the States along the Atlantic

and legislate in respect to improving by irrigation or otherwise the lands within their borders."

It then notices the provisions of Section 8 of the Act of June 7, 1902, as indicating the purpose of Congress not to disregard the limitation upon its power and then, as though to foreclose further consideration of the subject, it is said:

> "But it is useless to pursue the inquiry further in this direction. It is enough for the purposes of this case that each State has full jurisdiction over the lands within its borders, including the beds of streams and other waters."

From which the Court concludes, that each State

> "May determine for itself whether the common law rule in respect to riparian rights or that doctrine which obtains in the arid regions of the West of the appropriation of waters for the purposes of irrigation shall control. Congress cannot enforce either rule upon any State."

Following this conclusion, the Court says:

> "May we not consider some appropriation by Colorado of the waters of the Arkansas to the irrigation and reclamation of its arid lands as a reasonable exercise of its sovereignty and not as unreasonably trespassing upon any rights of Kansas?"

The opinion throughout seems to us a definite recognition of a sovereign right in and over the

waters flowing within its boundaries subject to no limitation save such as by the act of union and the terms of the Federal Constitution the Supreme Court of the United States in case of controversy may deem essential to the preservation of the equality of rights between the States.

In *U. S. vs. Hanson,* 167 Fed. 881, Judge Gilbert construes the opinion to be a denial of any power in Congress to interfere with State control which control, subject to the power of Congress to regulate commerce, is vested wholly in the States.

We next refer to the cases of

Rickey Land & Cattle Co. vs. Miller & Lux, 218 U. S. 258, and

Bean vs. Morris, 221 U. S. 485.

In both of these cases the views of the Court, as stated by Mr. Justice Holmes, seem to be irreconcilable with the contentions of the Government counsel. In the latter case, he says:

> "We know no reason to doubt, and we assume that, subject to such rights as the lower States may be decided by this Court to have, and to vested private rights, if any, protected by the Constitution, the State of Montana has full legislative power over Sage Creek while it flows within that State. Therefore, subject to the same qualification, we assume that the concurrence of the laws of Montana with those of Wyoming is necessary to create easements or such private rights and obligations as are in dis-

pute across their common boundary lines. * * * It follows from what we have said that it is necessary to consider what limits there may be to the powers of an upper State if it should seek to do all it could."

We think it must be conceded that the foregoing gives no support to the theory that the right of appropriation is derived from and depends upon the jurisdiction of the United States, and therefore a right common to both States.

The argument of counsel in the main is based upon inferences which they think may be drawn from decisions relating to the power of Congress to dispose of and make all needful rules and regulations respecting its property and specifically concerning treaties made in connection therewith. Such power being derived from the Constitution, it follows that each State is bound thereby, whether one of the original or one of the newer States, all States being in respect thereto upon an entire equality. It is a power of which the original States made surrender and each State comes into being upon the same terms. But was the delegation to the Federal Government of the power a surrender of anything more? Was it a surrender by the States of the ultimate jurisdiction or sovereignty over the lands which the Government possessed? We understand it is conceded that the moment the Government title passes the proprietary and sovereign right, which the Government theretofore possessed, ceases, and that the land becomes subject without qualification to precisely the status it would occupy if the Gov-

ernment had never appeared in the chain of title, in other words, as though the lands were within one of the original States.

If the argument of counsel is to have any value whatever in this or similar cases, it must clearly demonstrate that, although the Government owns no land in a State created out of the public domain, it nevertheless possesses as a residuum from its original ownership of all the lands in the State, the jurisdiction to originate titles to the use of the water within the State, and, if in its wisdom thought wise, to formulate laws regulating the appropriation and use of water to the exclusion, if need be, of the laws of the State bearing upon the subject. A potent, but not necessarily conclusive, argument against any such view is the fact that Congress has never assumed or asserted any such power. As we have said, the power over the territory or other property of the United States is a granted power, and the question, therefore, is not so much what does the Federal Government possess, but what did the State governments intend to give? Did they surrender jurisdiction and control of those elements of material prosperity without which state development might be arrested and state ambitions defeated? Of this paragraph in the Federal Constitution, Mr. Justice Brewer, in the *Kansas-Colorado* case, *supra,* said:

> "The full scope of this paragraph has never been definitely settled. Primarily, at least, it was a grant of power to the United States of control over its property.

> * * * But, clearly, it does not grant to Congress any legislative control over the States and must, so far as they are concerned, be limited to authority over property belonging to the United States within their limits. * * * The powers affecting the internal affairs of the States not granted to the United States by the Constitution nor prohibited by it to the States, are reserved to the States respectively, and all powers of a national character which are not delegated to the National Government by the Constitution are reserved to the people of the United States."

Now, the function which the Federal Government performs in the acquisition of territory and the creation therefrom of States of the Union, is pretty well discussed and settled by numerous decisions of this Court. While it is true that by the Louisiana Purchase and the several grants from Mexico, the United States became possessed of every shred of proprietary and sovereign title that the most favored nation, under like circumstances, could acquire, it was, nevertheless, never a part of our scheme of government that such conditions should be perpetual. This government of ours is primarily a union of States and the ultimate destination of all territorial acquisitions is the foundation of additional States, to the end that we shall continue as we commenced, as an indestructible union of indestructible States. Therefore, the Federal sovereignty and proprietary title of the United States in its territory is but a passing phase, a mere

preliminary to the time when such territory shall be carved into States. The States when so carved out of the territory of the United States, do not come into the possession of their powers by grant from the Federal Government, but because by the very fact of their existence they possess, in virtue of their definition and our political organization, all the powers, functions and sovereignties of their predecessors in the Union.

It was well said by Mr. Justice Lurton, in *Coyle vs. Oklahoma*, 221 U. S., at page 566, that

> "The definition of a State is found in the powers possessed by the original States which adopted the Constitution, a definition emphasized by the terms employed in all subsequent acts of Congress admitting new States into the Union."

It is this characteristic which, upon the creation of States upon the public domain, negatives the right of the United States to impose, by the enabling act or otherwise, any condition which in the slightest degree destroys this equality with every other State. Whatever may be the terms of the enabling act as to reservations or restrictions upon behalf of the United States, they are effective only to the extent that they could be enforced if not mentioned in the enabling act. In other words, the United States, or the Congress thereof, has no power, by virtue of anything contained in the enabling act, in excess of that which may be exercised in the newly created State after its complete establishment and

which likewise may be exercised if the same conditions were presented in any one or more of the original States.

All of this has been so often and so clearly stated that any elaborate quotation of opinions would be out of place; nevertheless, to preserve the continuity of our argument we shall recall the leading cases.

The first case in point of time was *Pollard's Lessees vs. Hagan*, 3 How. 212, in which, after noting the question presented, the Court said:

> "We now enter into its examination with a just sense of its great importance to all the States of the Union and particularly to the new ones. Although this is the first time we have been called upon to draw the line that separates the sovereignty and jurisdiction of the Government of the Union and the State governments, over the subject in controversy, many of the principles which enter into and form the elements of the question have been settled by previous well considered decisions of this Court, to which we shall have occasion to refer in the course of this investigation. * * * We think a proper examination of this subject will show that the United States never held any municipal sovereignty jurisdiction or right of soil in and to the territory of which Alabama or any of the new States were formed, except for temporary purposes and to execute the trusts created by

the acts of Virginia and Georgia legislatures and the deeds of cession executed by them to the United States and the trust created by the treaty with the French Republic of the 30th of April, 1803, ceding Louisiana" (p. 221).

Then, referring to the ordinance of 1787, which extended to the territory in question, the Court said:

"Taking the legislative acts of the United States and the States of Virginia and Georgia and their deeds of cession to the United States, and giving to each separately and to all jointly a fair interpretation, we must come to the conclusion that it was the intention of the parties to invest the United States with the eminent domain of the country ceded, both national and municipal, for the purposes of temporary government and to hold it in trust for the performance of the stipulations and conditions expressed in the deeds of cession and the legislative acts created with them. * * * When the United States accepted the cession of territory they took upon themselves the trust to hold the municipal eminent domain for the new States and to invest them with it to the same extent in all respects that it was held by the States ceding the territory. * * * Whenever the United States shall have fully executed these trusts, the municipal sovereignty of the new States will be complete throughout their respective borders and they and the

> original States will be upon an equal footing in all respects whatever. We therefore think the United States holds the public lands within the new States by force of the deeds of cession and the statutes connected with them and not by any municipal sovereignty which it may be supposed they possess or have reserved by compact with the new States for that particular purpose. The provision of the constitution above referred to shows that no such power can be exercised by the United States within a State; such a power is not only repugnant to the constitution, but it is inconsistent with the spirit and intention of the deed of cession" (pp. 223-4).

Escanaba Company vs. Chicago, 107 U. S. 678, furnishes another judicial land mark. In that case, Mr. Justice Field said:

> "But the States have full power to regulate within their limits matters of internal police, including in that general designation whatever will promote the peace, comfort, convenience and prosperity of their people. This power enbraces the construction of roads, canals and bridges and the establishment of ferries, and it can generally be exercised more wisely by the States than by a distant authority. They are the first to see the importance of such means of internal communication and are more deeply concerned than others in their wise management" (p. 683).

What was then said by Mr. Justice Field bears with peculiar force upon what we shall hereafter say concerning the wisdom of committing to the arid States respectively all matters relating to the appropriation, use and distribution of water.

Further speaking upon the subject, Mr. Justice Field said:

> "And although the Act of April 18, 1818, Chapter 67, enabling the people of Illinois Territory to form a constitution and State government and the resolution of Congress of December 3, 1818, declaring the admission of the State into the Union, refer to the principles of the ordinance according to which the Constitution was to be formed; its provisions could not control the authority and powers of the State after her admission. Whatever the limitation upon her powers as a Government, whilst in a territorial condition, whether from the ordinance of 1787 or the legislation of Congress, it ceased to have any operative force except as voluntarily adopted by her after she became a State of the Union. On her admission she at once became entitled to and possessed of all the rights of eminent domain and sovereignty which belonged to the original States. She was admitted and could be admitted only on the same footing with them. The language of the resolution admitting her is 'on an equal footing with the original States in all respects whatever.' Equality of constitutional right and power

is a condition of all of the States in the Union, old and new. Illinois, therefore, as was well observed by counsel, could afterwards exercise the same power over rivers within her limits that Delaware exercised over Blackbird Creek and Pennsylvania over the Schuylkill River" (pp. 688-9).

In *Shively vs. Bowlby,* 162 U. S. 1, Mr. Justice Gray, in the course of an exhaustive opinion in which all the previous decisions of the Court are brought into view, says:

"The United States, while they hold the country as a territory having all the powers both of National and municipal government, may grant for appropriate purposes titles or rights in the soil below high water mark of tide waters, but they have never done so by general laws, and unless in some case of international duty or public exigency, have acted upon the policy as most in accordance with the interest of the people and with the object for which the territories were acquired, of leaving the administration and disposition of the sovereign rights in navigable waters and in the soil under them, to the control of the States, respectively, when organized and admitted into the Union. Grants by Congress of portions of the public lands within the territory to settlers thereon, though bordering on or bounded by navigable waters, convey of their own force no title or right below high water mark and do not impair the title and

dominion of the future State when created, but leave the question of the use of the shores by the owners of uplands to the sovereign control of each State, subject only to the rights vested by the Constitution of the United States."

Other cases stating the same conclusions are the following:

Permoli vs. First Municipality, 3 How. 589.
Strader vs. Graham, 10 How. 82.
Cardwell vs. American Bridge Co., 113 U. S. 205.
Hamilton vs. Vicksburg Ry. Co., 119 U. S. 280.
Huse vs. Glover, 119 U. S. 543.
Williamette Iron Bridge Co. vs. Hatch, 125 U. S. 1.

The more recent cases in which this matter is discussed are *Coyle vs. Oklahoma*, 221 U. S. 559, in which Mr. Justice Lurton (p. 567) uses the following language:

"'This Union' was and is a union of States, equal in power, dignity and authority, each competent to exert that residuum of sovereignty not delegated to the United States by the Constitution itself. To maintain otherwise would be to say that the Union through the power of Congress to admit new States might come to be a Union of States unequal in power, as including States whose powers were restricted only by the Constitution when others whose

powers had been further restricted by the Act of Congress accepted as a condition of admission. Thus it would result:

First, that the powers of Congress would not be defined by the Constitution alone, but in respect to new States enlarged or restricted by the conditions imposed upon new States by its own legislation admitting them into the Union, and

Second, that such new States might not exercise all of the powers which had not been delegated by the Constitution, but only such as had not been further broken away as the conditions of admission. * * *

The plain deduction from this case is that when a new State is admitted into the Union it is so admitted with all of the powers of sovereignty and jurisdiction which pertain to the original States and that such powers may not be constitutionally diminished, impaired or shorn away by any conditions, compacts or stipulations embraced in the act under which the new State came into the Union, which would not be valid and effectual if the subject of congressional legislation after admission."

And in the already noticed case of *Kansas vs. Colorado*, in which, as a preliminary to a discussion of the relative rights of Colorado and Kansas to the waters of the Arkansas River, an innavigable stream, Mr. Justice Brewer said:

"But when the States of Kansas and Colorado were admitted into the Union, they were admitted with the full powers of local sovereignty, which belonged to other States, and Colorado, by its legislation, has recognized the right of appropriating the flowing waters to the purposes of irrigation."

And after speaking of the conflict between the laws of the two States, he says:

"Now, the question arises between two States; one recognizing generally the common law rule of riparian rights and the other prescribing the doctrine of public ownership of flowing water. Neither State can legislate for or impose its own policy upon the other. * * * Each may determine for itself whether the common law rule in respect to riparian rights or that doctrine which obtains in the arid regions of the West of the appropriation of waters for the purpose of irrigation shall control. *Congress cannot enforce either rule upon any State.*"

It would seem that what we have already said would be sufficient to dispose of the question, nevertheless it may be contended that we have not yet definitely brought within the principles enunciated, the matter of whether a State, as against the United States, can absolutely exclude the United States from claiming either sovereign or proprietary interests in its waters, or whether the United States can, by act of Congress, legislate concerning the same.

Generally speaking, we understand that the laws of Congress applicable to territories, so far as they concern matters over which the State will have ultimate sovereignty are as temporary as the government title to lands included therein; that is, the rules and principles of territorial government are temporary and subject to be displaced upon the coming in of the State. If, for example, Congress should have given to its lands the common law incident to riparian ownership, the State, in its wisdom, could have displaced that doctrine by the necessary and therefore more appropriate doctrine of appropriation. Or, if the State had deemed the common law doctrine the necessary and appropriate one, it would not be restrained from adopting it by the act of 1866. Such is certainly the logical conclusion to be drawn from the following cases:

In *U. S. vs. Rio Grande Irrigation Company*, 174 U. S. 690, after referring to the common law doctrine of riparian rights, Mr. Justice Brewer said (p. 702):

> "While this is undoubted, and the rule obtains in those States in the Union which have simply adopted the common law, it is also true that as to every stream within its dominion a State may change this common law rule and permit the appropriation of the flowing waters for such purposes as it deems wise."

In *U. S. vs. Cre* 43 U. S. 316, Mr. Justice Pitney says:

> "The States have authority to establish for themselves such rules of property as they may deem expedient with respect to the streams of water within their borders, both navigable and non-navigable, and the ownership of the lands forming their beds and banks, subject, however, in the case of navigable streams, to the paramount authority of Congress to control the navigation so far as may be necessary for the regulation of commerce among the States and with foreign nations; the exercise of this authority being subject, in its turn, to the inhibition of the Fifth Amendment against the taking of private property for public use without just compensation."

In *Hawkins vs. Bleakly*, 243 U. S. 210, Mr. Justice Pitney further says, speaking of what was claimed to be the constitutional guarantee secured to the inhabitants of the State of Iowa by the ordinance of July 13, 1787 (p. 217):

> "It is contended that the guarantees contained in the ordinance were extended to Iowa by the Act of Congress approved June 12, 1838, establishing a territorial government and by the acts for the admission of the State into the Union. This is easily disposed of. The Act of 1838 was no more than a regulation of territory belonging to the United States, subject to repeal like any such regulation, and the Act for admitting the State, so far from perpetuating any particular institution previously established,

admitted it 'on an equal footing with the original States in all respects whatsoever.' The regulation, although embracing provisions of the ordinance declared to be unalterable unless by common consent, had no further force in Iowa after its admission as a State and the adoption of a State Constitution, than other acts of Congress for the government of the territory. All were superseded by the State Constitution."

The cases cited by counsel refute rather than sustain their contention that the Government remains the owner and entitled to dispose of and administer the waters of the arid States. A good deal of confidence seems to be reposed in the decision in *Winter vs. U. S.*, 207 U. S. 564, because it was rendered after the decision in the Kansas-Colorado case. But it will be observed that although the opportunity was presented to recognize the theory now advanced, the Court did not do so, but places its decision upon the basis of a reservation of water for certain lands concerning which the Government had entered into treaty obligations with the Indians. A resort to reservation as the basis of the Government's position in that case was a clear recognition of the fact that except for the reservation, plenary jurisdiction over its waters was vested in Montana upon its admission as a State. Moreover, the reservation was expressed in a treaty which, although entered into with an Indian tribe, nevertheless, as a treaty, possessed the quality of being superior to

the constitution and laws of Montana and of every other State as well.

U. S. Const., Art. 6, § 2.
Hauenstein vs. Lynham, 100 U. S. 483, 490.
U. S. vs. Winans, 198 U. S. 371.

The case of *Gutierres vs. Albuquerque Co.*, 188 U. S. 545, and that of *Boquillas Land & Cattle Co. vs. Curtis*, 213 U. S. 399, are not apposite to the present controversy, the first entitled case having to do with the territorial status of New Mexico, and the second having to do with the rights of a grantee of the State of Sonora to the waters of an arid State.

The only case from which there is any possibility of obtaining support for their theory is *Sturr vs. Beck*, 133 U. S. 541. We have never been impressed by the reasoning of the opinion in that case. The conclusion seems to have been forced and as an authority it should be narrowed to the precise state of facts and the territorial laws of Dakota, and not given any effect as the statement of a universal principle. We think Mr. Justice King was right in saying in *Hough vs. Porter*, 98 Pac. 1083, 1098, that it was overruled by the decision in the *Kansas-Colorado* case.

We conclude that counsel are correct in saying that the question whether the United States or the States own the water of innavigable streams in the West has never been passed upon directly in this Court, if by that statement they mean that they can find no direct support for their theory in anything that this Court has heretofore said. Ownership is hardly the term to use in this connection, since it im-

ports a mere proprietary relation to property. When a part of the territory of the United States is included within a State, the relation of the State to that territory becomes that of a sovereign—a status of paramountcy thereafter prevails antecedent and superior to proprietary right. The sovereign right of dominion which temporarily resided in the United States is assumed by the State, not transferred to it. This sovereign right of dominion over persons and property exists in every State without qualification, except as modified by the universal limitations of the Federal Constitution. Thus, as stated by Mr. Justice Holmes in *Bean vs. Morris, supra:*

> "Subject to such rights as the lower state might be decided *by this court* to have and *to vested private rights, if any, protected by the constitution,* the State of Montana has full legislative power over Sage Creek while it flows within the State."

Mr. Justice Van DeVanter succinctly stated the principle as applied to Colorado in *Snyder vs. Colorado Gold Dredging Co.,* 181 Fed. 62, 65, where he said:

> "In so choosing between these inconsistent doctrines (that is, the doctrine of riparian right vs. the doctrine of appropriation, etc.), Colorado acted within the limits of her authority first as a territory and then as a State, and her choice was recognized and sanctioned by Congress so far as the public lands of the United States were concerned."

We know, of course, that the opinions of the officers of the several departments of the government have no force in this Court beyond their persuasiveness, but the opinions of the Land Department, to whose keeping is committed the disposition of the public lands, may properly be referred to, because they indicate that counsel are now advancing a theory not heretofore entertained in that department.

In the regulations concerning right of way for canals, ditches, etc., under the Act of March 3, 1891, the Department of the Interior said:

> "The control of the flow and use of water is therefore a matter exclusively under State or Territorial control; the matter of administration within the jurisdiction of this Department being limited to the approval of maps carrying the right of way over the public lands."

26 L. D. 520, 524.

And on December 24, 1900, Acting Secretary Ryan reaffirmed the statement in *New Bear Valley Ir. Co. vs. Roberts*, 30 L. D. 382, 386, where he used the following language:

> "The question of the ultimate rights of the parties hereto in and to the waters of said streams under their respective notices of appropriation is solely within the jurisdiction of the state courts and in pursuance with the policy announced in the case of Chicala Water Co. vs. Lytle Creek, the Department will not attempt to interfere

with the control of said waters or determine the rights of the conflicting claimants thereto, except insofar as may be necessary to ascertain whether the applicant has shown such *prima facie* right to the use thereof as will enable him to utilize for the purposes contemplated the grant for which he has applied."

In *Silver Lake P. & I. Co. vs. Los Angeles*, 37 L. D. 152-3, First Assistant Secretary Pierce, on September 9, 1908, stated that:

> "The Department is without jurisdiction to determine the question as to the right to water, that being a matter solely within the province of the state courts."

That Department clearly recognizes the fact that it was dealing with the territory of the United States as the agency of Congress in a proprietary as distinguished from a sovereign sense and with the limitations imposed by the former against the breadth of the latter. That the department was right is evidenced by the opinion of Mr. Justice Van DeVanter in *Utah L. & P. Co. vs. U. S.*, 243 U. S. 389, 410, where he says:

> "Much is said in the briefs about several Congressional enactments providing or recognizing that rights to the use of water in streams running through the public lands and forest reservations may be acquired in accordance with local laws, but these enactments do not require particular mention, for this is not a controversy over water

> rights, but over rights of way through the lands of the United States, which is a different matter and is so treated in the right of way acts before mentioned."

And then he cites *Snyder vs. Colorado Gold Dredging Co.*, 181 Fed. 62, 69, to which we have already called attention.

Section 8 of the National Reclamation Act (Act of June 17, 1902—7 Fed. St. Ann., 1905, p. 1098), clearly limits that act and recognizes the same limitations upon the Government already noted with regard to the Act of 1891. Such was the statement concerning the effect of the act during the debates in Congress and such has been the interpretation thereof by the courts.

> *Con. Record,* Vol. 35, Part 7, pp. 6679-80..
> *Kansas vs. Colorado,* 206 U. S. 46, 92.
> *United States vs. Hanson,* 167 Fed. 881, 884, 93 C. C. A. 371.
> *Twin Falls Canal Co. vs. Foote,* 192 Fed. 583, 594.
> *Bergman vs. Kearney,* 241 Fed. 884, 892-3.

In the last case above cited (*Bergman vs. Kearney*), decided March 3, 1917, by the United States District Court of Nevada, it was contended that all unappropriated waters "belong to the United States Government" (p. 899), the same contention made by counsel in this case, but the argument was treated by the Court as "largely academic, and could lead to no profitable or decisive conclusion," and the unappropriated waters were declared to be the property and under the control of the State (241 Fed. 892-3).

There are some things said by counsel that seem to us quite true; for instance, they say:

> "It is difficult to see how priority of appropriation can be adopted as the rule of decision in this case without taking the federal title as a basis. If we eliminate the rights of the United States and the power of Congress to dispose of those rights and the consideration that the owner of those rights is a sovereign, we have two states facing each other simply as paramount land owners. As such, how can they be confined in their rights in the stream to the water that they have already appropriated, and, as to the surplus waters, be given merely a right to make further appropriations. *The fact that their laws both recognize priority of appropriation as governing the rights of their citizens can have no bearing.* These laws in neither instance were made to govern the State itself as against another State. No rule of comity could apply in a case where the States are seeking to assert rights in *in vitum* against each other. Furthermore, Colorado has lately passed an act designed to retain such waters as she controls within her own borders (Act of March 30, 1917, Session Laws of Colorado 1917, page 539)."

Counsel might have gone much further and said that not only must the federal title be the basis of appropriation, but Congress must supplant all State laws and regulations and give uniformity to all the

laws, rules and regulations respecting the initiation and maintenance of irrigation and other rights, the determination of conflicting claims to water and provide the official force necessary to meet the daily and hourly changes in the flow of the natural streams and the conflicting interests of the various appropriators. The conflicting claims of appropriators in adjoining States from the same stream can never be ascertained, adjudged or regulated so long as each State, or the State called upon to surrender to the demands of the other, refuses to recognize appropriations not made within its borders. It may be said that such a condition of uniformity may be obtained by judicial decree, which would mean that the Federal Court should formulate the rules which should govern. But this would be not only impractical, but in violation of the proper functions of the Court. That Court would be compelled to assume the legislative functions of both Wyoming and Colorado and to become, in effect, an administrative board constantly in session for the purpose of securing to the several appropriators and to the State as well, in respect to the proper utilization of water, the benefits of irrigation.

We fear that some people, and we are sorry to note that this is true of the Government counsel, think that a right of appropriation is an isolated right that when once ascertained, is free from any relation to other appropriation rights. Such is not the case. Each appropriation right, under a highly developed system such as prevails in Colorado, is relative to all other appropriation rights from the same stream, even though they may be, as occurs in

Colorado, 200 miles apart. The principal streams of Colorado, with their tributaries, constitute a single irrigation division in which hundreds of appropriations have been made, and over which the superintending control of the State of Colorado is being daily and hourly exercised for the purpose of securing due observance of the laws of the State and the maintenance of its interests in seeing that the water is beneficially used and that water shall not be taken from the river except when the needs of the land under a particular ditch may require, and that the headgates of the several ditches which are no longer under the private control of the appropriator, but under the control of State officials, shall be closed or opened according to the needs of the appropriator and in accordance with the conditions of supply which may obtain at particular times.

While it is true, paraphrasing the language of Mr. Justice Holmes in *Bean vs. Morris*, that the doctrine of appropriation has prevailed in Wyoming and Colorado probably from the first moment that they knew of any law, and that it was recognized by the statutes of the United States while they were both territories, and that it is recognized by both States now, it does not follow that priority of appropriation is the only attribute of the doctrine. To determine contests between appropriators in different States by that single factor would be to return to the primitive stage of irrigation, when contests over water were purely private contests, relieved of all public concern. But today the science of irrigation, because it has become both a science and an institution, is very little concerned with such primitive notions as who was first in time, as the test of first in right.

We think we are entitled to say that Colorado, because of her extreme arid condition and because, except by the use of her running waters, she must always remain arid, has developed the institution to a point in advance of any other State. But it is to the same degree of finish that other States may be expected to come. So that we are contemplating now, not the mere matter of whether A in Wyoming was prior to B in Colorado, but we are placing the systems of two States in juxta position and in doing so we find that while they are in agreement as to the necessity of irrigating land and to the protection of appropriators, the ways and means and the regulations concerning the subject are far from being identical. The laws of Colorado occupy pages; they determine the conditions under which appropriations may be made, the manner in which they shall be evidenced; they give to the courts special statutory powers to inquire into and determine the rights of the several appropriators; they divide the different water divisions into districts, with a commissioner in each district to keep in daily and hourly touch with the distribution of water, and over the whole system, and as its head and center they place the State Engineer, who is vested with authority to so direct and control the various Division Engineers of each division and Water Commissioners in each water district throughout the entire State of Colorado, that the waters may be at all times beneficially and economically applied in accordance with the several and respective rights of the different appropriators, restrained as they at all times are by the dominant public interest in the wise and proper application of

the water. Wyoming, on her part, has laws either sufficient or tending to be sufficient for the same purpose, but her machinery is different, practically from the first manifestations of a desire to take water up to the moment of its final application. The laws of all the appropriation States differ, and if an appropriator in one State were required to ascertain his rights by reference to the laws of the adjoining States, he would find himself in a state of utter confusion. The test by which to determine the amount of water to which one is entitled, the conditions which would be deemed an abandonment, the procedure in case of shortage, the right to store and the regulation of storage and nearly every incident to the system, have no correspondence in the laws of the various arid States. As is shown by the brief of counsel for the Government, States differ fundamentally, some having mixed conditions, as, for example California, Oregon, Nebraska and probably some others.

We understand that the inquiry of the Court by its recent order is directed to ascertaining not what disposition may be made of the present controversy, but what universal rule should be adopted in case of controversies between States or between appropriators in different States when the laws or the courts of the upper State refuse to recognize or enforce the claims of appropriators in the State or States below. Apparently the time has been reached when it is necessary, quoting the language of Mr. Justice Holmes in *Bean vs. Morris*, to "consider what limits there may be to the powers of an upper State if it should seek to do all that it could." It seems to us that no

rule can be applied, save that which was adopted by Mr. Justice Brewer in the *Kansas-Colorado* case, but the conclusion in that case in our judgment is but a theoretical one, because we cannot conceive that a time will ever arrive when in the wise, judicious and beneficial application of water in Colorado to the reclamation of arid lands and the improvement of the welfare of her citizens, it could be said that Colorado had destroyed the equitable apportionment of benefits between it and a lower State resulting from the flow of a river. Just where the line can ever be drawn it is impossible for us to say, and with all due deference we submit that it is idle to consider it, because there are certain provisions of nature which no human laws can override which serve to maintain an equilibrium of benefits. While Colorado asserts the right to divert all the waters of a stream originating in and flowing through her territory, this is itself but a theoretical assumption, because she does not possess the power to overcome the laws of gravity, nor the direction of moving water in the mass. She may construct dams, she may construct ditches, and she may divert vast volumes of water to the thirsty soil, but when that thirst is appeased the water returns to its former course; and all that has been accomplished by the diversion, as broad and ample as it may be, and the broader the more ample, the more generous the result, she has done nothing but strengthen the flow of the river below the point of use—not strengthened it under flood periods, but strengthened it by equalizing the flow throughout the year.

Let us, in conclu illustrate our contention that there is a law of co..r ion as between States as well as in other r : When the case of *Kansas vs. Colorado* w nstituted, the substantial basis of complaint was there was an underflow underlying the entire . ..sas Valley, which operated beneficially upon surface soil by a form of sub-irrigation. It wa claimed that the diversion of water in Colorado ha: . ered the level of this underflow so that it n onger performed the valuable services theretofore p . med. Since that case was decided, it has been di vered by the advance in electrical science and . improvement in elevating devices that this under is itself as good a supply for the lands in the va of the Arkansas as would have been the surfa ers of the river. The generation of electric the conveyance of the current to the various s permits the pumping of water at no greater exp than is required in the construction of a dite and the diversion of water from a river where the modern perfectness of that method is adopte

OTHER AUTHORITI CITED BY COUNSEL FOR THE D STATES.

Further or ex ed discussion of the cases cited by counsel for United States would serve no useful purpo ... this case. These relate in the main, to the relative e rights of either riparian owners or appropri rs and not to the greater and sovereign rights of States in and to the control of the natural eleme e waters of the streams irrespective of mere p rights. These cases are

largely cited as a basis for the fundamental contention of counsel, that "all the riparian owners on a stream taken together, therefore, may grant such rights in the stream as they see fit. Together they own the entire stream," etc., as a premise to the theory of Government ownership and grant. But in the reasoning of these many cases there nowhere appears or was involved, the fundamental principle that the States in this government of delegated powers have an interest in their streams superior to that of all riparian owners or appropriators and greater than any title or interest which all riparian owners or appropriators combined could convey to a common grantee (*Hudson Water Co. vs. McCarter*, 209 U. S. 349) and the Laramie River or any streams in Iowa, Missouri or other portion of the Louisiana Purchase or any other portion of what was originally the public domain, would appear to be subject to same state control as the streams of New Jersey (*Kansas vs. Colorado*, 206 U. S.; *Marshall Dental Co. vs. Iowa*, 226 U. S. 460; *United States vs. Cress*, 243 U. S. 316).

It is here contended by Wyoming that all the water of the Laramie river has already been appropriated. Under contention of counsel for the United States any discussion of the law of derivation of original title would seem of little value for the reason that, under the theory advanced, these waters have all passed into private hands and like lands gone to patent, are now within the sovereign control of the two states. It is the control of these waters after they have passed into the hands of appropriators that is here involved and the source of the original

title, whether directly from the government by grant according to local laws, customs and decisions of the courts of the respective States as provided by the Act of 1866, or whether by permissive use by the States of one of the great natural and necessary elements of life, is of no moment unless, in fact, if the title be deemed to have been derived by the appropriator directly from the Government, it can then be said that the Government continues to supervise and control the use of the water acquired under the right forever thereafter, irrespective of the laws or necessities of the States. If such be true, control of the waters of the non-navigable streams of Iowa, Illinois or any other public land State must likewise remain perpetually in the United States. Waters of the streams require no particular control or supervision until after appropriation or after riparian, municipal supply or other like rights have attached thereto, except it be for the public protection of the purity of the streams and other like purposes, and academic discussion of the cases cited would be of no ultimate benefit to the court. We however suggest, that nowhere in the brief is there mention of any method, system or machinery by which governmental control could be carried out in a practical manner under, necessarily, one system of laws.

SOME FINAL OBSERVATIONS CONCERNING THE EXTENT OF THE INQUIRY NECESSARY TO BE MADE TO DETERMINE CONTROVERSIES BETWEEN STATES AND BETWEEN RIVAL APPROPRIATORS IN ADJOINING STATES.

Finally, we return to what we said in the opening of this brief to the effect that the matter in hand should be disposed of by reference to the present stage of irrigation development, free from the embarrassment of primitive or obsolete practices or legal conceptions. The question whether the upper State has a full or limited control of the waters flowing through it should be settled definitely and finally. The assaults made upon Colorado by Kansas, Wyoming and Nebraska, successively, not only cloud present titles, but intimidate those desiring to further develop our resources by the more extended use of our waters, and constantly present the problem whether to preserve a supposed equilibrium between Colorado and adjoining States, it may not be necessary to undo something that has been done in Colorado.

With the principle announced in the *Kansas-Colorado* case, upon the basis of which the Supreme Court is enabled to exercise its powers as an interstate tribunal, whenever a substantial reason is presented, we cannot take issue. It is the practical application of the principle that suggests the possibility of injustice. If we consider the particular issue in that case, the unsolved and, as we think, unsolvable, problem was and is: When shall it be said that in the proper and beneficial uses of the waters of the Arkansas River Colorado has reached a point

where the substantial interests of Kansas are injured? And this inquiry, of course, is true of every stream flowing from Colorado into adjoining States. Can the precise point in time or in events be determined? And is it to be ascertained before or after the event? The opinion of Judge Brewer seems to contemplate that the Supreme Court is to act after the point has been passed, which, of course, means that equality is to be produced by a destruction of such development in Colorado as is in excess of what the Court may then fix as the sovereign limit of development. Thus the Court would say to Colorado, your pile is too high, we must sweep a portion of it into Kansas or Wyoming or Nebraska, as the case might be. All of this, in our judgment, denies the further influence in the States concerned of the processes of nature and the genius of man which ought to, and doubtless will, solve problems of this character.

It is true that Colorado and Kansas and Wyoming and Nebraska are States of the Union and amenable to the Constitution which binds them together, but they are at the same time living social and political organisms, entitled to exercise within themselves, respectively, every power and function appropriate to their up-building. And as these powers and functions must operate upon things as well as upon persons, it ought to follow that nothing that has been placed within their physical control should be withdrawn from them, nor should a sword be suspended over their activities, to fall when, in the judgment of the Supreme Court, they should cease. When the people of Colorado assert a right to the

use of all their waters as an attribute of sovereignty, they mean nothing more than that the very nature of a State involves the right to so use its own resources as to advance and contribute to its welfare, and thus to the welfare of the whole country. Is there anyone bold enough to say that the people of Colorado, who have been without government aid in the carrying out of their projects, have not added vastly to the welfare and prosperity of the Union? And with some degree of pride, may we not ask whether there is any one bold enough to say that Colorado has not been in advance of all other States in demonstrating that arid lands may be made fruitful and that the courage and genius of her people have not been of first importance in enabling Congress to dispose of its arid territory? And, yet, if we are to accept the principle of Kansas against Colorado as a living thing, liable to strike at any moment, Colorado and her people must from now on rest under the heavy hand of repression.

So far as the effect upon Colorado is concerned, there is little practical difference between apportioning waters in the mass as suggested in the *Kansas-Colorado* case, or apportioning them by giving to appropriators in Wyoming or any lower State priority over appropriators in Colorado. We are pobably correct in saying that the latter would be the more fatal of the two, because it not only refuses to Colorado the full use of its waters, but it impairs the ability of Colorado to carry to its full fruition the doctrine upon which the use of water in Colorado is founded, namely: That the water belongs to the people and that its use shall at all times be beneficial.

By beneficial is not meant privately beneficial alone, but beneficial from the standpoint of the inital public interest. In Colorado, and we think the same is true of all the arid States, the individual appropriator is but a cog in the machinery or process of irrigation development. He has no independent exclusive right to water, to do with it as he likes, as he may with all other forms of property. On the contrary, he is deemed to be using a public fund, and he must use it to the satisfaction of the public, and he is not left to determine that matter for himself. The State, in the person of its water officials, superintends his taking of water and must be daily satisfied that it is then necessary to his use. If he ceases to use it for an unreasonable time, his right ceases and the water returns to the common fund. He is never free from an obligation to the State and its citizens, as well as to those who are making a like use of the public waters. Thus it is that each State has by law, usage and custom formulated, with more or less claim to completeness, a system of irrigation, the foundation stone of which is necessarily administration. Each State is an administrative unit, in which the success of the system is dependent upon the centralization and unification of jurisdiction and authority in the sovereign power of the people. The rivers in the arid States are fluctuating in volume and usefulness. They may have tidal aspects when the snows of the mountains are alternately melted by the warmth of the day and frozen by the chill of the night. Under these conditions, they rise and fall much after the order of the tides. During some days, and even months, the lower reaches, as was testified in the

Kansas-Colorado case, may not contain upon the surface enough water for a thirsty horse. In the distribution of water for irrigation all contributing supplies, whether by storms or tributary streams, or other temporary causes, must be observed by the water officials and the right to water at the different points of diversion must be daily determined by the river, and even by barometric, conditions then presented. Conservation is the paramount law in the distribution and use of water. Each State devises its own system. Each State is a law unto itself and not unto another, and each State must be unimpeded in the carrying out of its system, else the condition of efficiency, which it is the object of the State to maintain, will be impaired, if not destroyed.

It must be perfectly evident, therefore, that if an appropriator in a lower State may inject his supposed right into that system, he not only takes the water from some one or more of the parties to that system, but impairs the system itself. In other words, he does not strike at an individual appropriator only, but he strikes at the common welfare of the State as endeavored to be promoted by the system. If one appropriator in a lower State may inject himself into the distribution of water in an upper State, a second, a third and an indefinite number may do so, and thus we would have such a series of interpolated claims that the principal duty of the upper State would be to administer its waters in behalf of appropriators in the lower State.

In the *Kansas-Colorado* case, Mr. Justice Brewer said:

> "Now the question arises between two States, one recognizing generally the common law doctrine of riparian rights, the other prescribing the doctrine of public ownership of flowing water. Neither State can legislate for or impose its own policy upon the other."

In the present case, we have to deal with States, in both of which the latter doctrine prevails. This, however, does not negative the fact that the laws of the two States may be different. That they seek a common object does not mean that they adopt a common method. The harmony of the former does not demonstrate the harmony of the latter. All Christian religions are agreed upon the need of salvation, but the most bitter and bloody contests the world has ever known have been over the methods of reaching that desired goal. There is no uniformity in the laws of the several arid States concerning the acquisition, use or administration of water. A cursory examination of the laws of the several States, as set forth in Part 8 of *Weil on Water Rights,* Third Edition, will verify this statement. Not only is there no concurrence of the statutes, but there is a wide variance in judicial opinions, depending to a large degree upon the extent to which the judges are unable to rid themselves of their inherent juridical conceptions of the sacredness of private property. The initiation and history of water rights in Wyoming is different from Colorado. The administration of water in each State is by a different system.

In addition to present variations in the laws of the several arid States it must be borne in mind that still others may occur, as the law, as well as the practice of irrigation and, indeed, of all other uses of water, is still in a state of flux. In no respect has the law or practice settled down to the fixity of the common law doctrine. And let it be remembered in this connection that it took England several centuries to finally and definitely formulate its present doctrine. We must contemplate the possibility that a State may revolutionize its law of waters. New Jersey slumbered along for many years, as time goes in a new country, before it awoke to the fact that back of and superior to the private rights of riparian owners there was a public right that it was entitled to protect. Colorado is not bound to continue its present laws or make them conform to those of Wyoming, nor is Wyoming or Nebraska or Kansas bound to maintain harmony with the laws of Colorado as the basis of a sovereign or individual right to water. Suppose Colorado should conclude to adopt laws similar to Kansas, conceding to riparian owners the right to irrigate, and thus by uses following the course of the stream the water should be exhausted before it passed into Kansas, Nebraska or Wyoming, would these riparian rights be subject to curtailment in the interest of the lower State or other appropriators?

In brief, can this Court, in this or any similar controversy between States, predicate anything upon any actual or supposed concurrence of the laws of the two States? If States assert rights against each other in the waters of interstate

streams, the extent of those rights must be determined by material and physical conditions and by measuring the extent of the resource to which each State is entitled and not by the temporary state of their laws, unless it should be that by their laws they have surrendered something definite. In our judgment, in this as well as in any other controversy which may arise between Wyoming and Colorado, or any other lower State and Colorado, this Court cannot justly apply either the method adopted in the Kansas-Colorado case or the method of recognizing appropriations regardless of state lines. Whatever may be true of the former, because of the fact that *Kansas vs. Colorado* is a precedent, it is, nevertheless, beyond reasonable dispute that to permit an individual appropriator in a lower State to assert and maintain claims against the appropriators in Colorado, would be to destroy and set at naught that system which lays at the foundation of success in irrigation, as well as the success of the United States in the disposition of its territory.

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